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THE ART OF COOKING.*

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THE cost of materials which are used for food comes to one half or more of the average income of at least ninety per cent of the people of this country; yet our product of food material is more abundant in ratio to population than that of any other country which holds a prominent position in the civilized world. This food consists in greatest measure of grain, meat, dairy products, and roots or tubers; in small part of fish, green vegetables, and fruit. The greater part of this food must be converted into a digestible and appetizing form by the application of heat to it at the right temperature, the degree varying with different kinds of food; this heat must be applied for a suitable time, also varying with the kind of material which is to be converted into a nutritious form by its action. Yet there are no popular treatises or definite instructions on the scientific application of heat to food.

Good health depends in greater measure upon adequate nutrition and upon the conversion of food material into a digestible form than upon any other factor in life. A well-nourished man can bear adverse conditions of life in the dwelling-house, the factory, the mine, and the furnace, to which the ill-nourished man will succumb in a very short time. On the other hand, the capacity of the man to perform his work is as fully dependent upon the quality and adequacy of his food as the capacity of the horse, ox, or mule. The force of the man depends on his food as much as the force of the engine upon the fuel used under the

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boiler; this is almost as true as to mental as it is to physical power.

There are innumerable treatises upon the feeding of animals; upon the generation of steam; upon the construction and ventilation of buildings; upon the arts which relate to clothing the human body, and upon keeping the dwelling and workshop warm; and, lastly, yet more numerous treatises or cookery-books upon the art of mixing and preparing the food which is to be cooked; there are also many treatises, chemical and physiological, upon the subject of nutrition, and there are one or two treatises on the science of cooking, notably Dr. Mattieu Williams's "Chemistry of Cookery"; yet, so far as the writer has been able to ascertain the facts, there is no receipt-book or cookery-book in common use which deals with the actual art of cooking by directing the right application of heat for a suitable time and at a suitable degree, to the specific food which is to be converted into a nutritious form by the conversion of its elements into new forms or conditions by the action of heat upon it.

It is possible that greater attention has been given to this matter in England than in this country. After trying in vain to find an oven thermometer in the United States, I lately imported one from England, made by Joseph Davis & Co., Fitzroy Works, London, S. E., and purchased at an agricultural show at retail for seven shillings sixpence, gauged at 200° to 600° Fahrenheit. On this thermometer are marked the respective degrees to which various kinds of food should be subjected, as follows:

Pork	320° Fahr.	Puff pastry	340° Fahr.
Veal	320 "	Bread	340 "
Beef	310 "	Pastry	320 "
Mutton	300 "	Meat-pie	290 "

These figures agree substantially with my own experiments as to the maximum of heat, but I do not concur with the inference that less than 200° Fahr. may not be permitted, if time be given for the lower degree of heat to do its work. On the contrary, any kinds of very tough meat may be reduced to a very tender condition by the long application of heat at 180° to 200°, without loss of flavor or nutritious property, provided the food be put into substantially air-tight vessels. The testimony of Dr. Mattieu Williams is conclusive on this point, as well as the special knowledge of the few good cooks of the method of simmering as distinguished from boiling. Meats and grains may be most nutritiously cooked at less than a boiling heat, and eggs should always be; while most kinds of roots, tubers, and vegetables require a higher degree.

I venture now to give some of the general conclusions which I have reached by the application of somewhat crude methods and

inventions on which I have experimented personally in such scraps of time as I could spare from my regular occupation, and on nearly two years' use of my apparatus in my own family.

I will challenge attention and discussion by first submitting some very positive and dogmatic statements, subsequently sustaining them by such proofs as I have to offer:

1. Special apparatus for boiling and frying has been adequately and suitably developed for the use of those who can afford these somewhat wasteful methods of preparing food, yet excellent when skillfully practiced.

2. The ordinary methods of frying are utterly bad and wasteful.

3. Bread may be baked suitably in a brick oven, and also economically, when the work is done upon a large scale.

4. It is very difficult to bake bread in a suitable way in the common iron stove or range; for this, among other reasons, most of the bread consumed in this country is very bad, although we have the greatest abundance of the best material.

5. Meats may be well roasted in a costly manner before an open fire.

6. Aside from the exceptional apparatus or methods named, substantially all the modern cooking stoves and ranges are wasteful and more or less unsuitable for use. All the ordinary methods of *quick* baking, roasting, and boiling are bad; and, finally, almost the whole of the coal or oil used in cooking is wasted.

7. The smell of cooking in the ordinary way gives evidence of waste of flavor as well as a waste of nutritious properties; and in most cases the unpleasant smell also gives evidence that the food is being converted into an unwholesome condition, conducive to indigestion and dyspepsia.

8. Nine tenths of the time devoted to watching the process of cooking is wasted; and the heat and discomfort of the room in which the cooking is done are evidence of worse than waste.

9. The warming of the room or house with the apparatus used for cooking is inconsistent with the best method of cooking, and might be compassed at much less cost if the process of cooking were separated from the process of warming the room or dwelling.

10. No fuel which can not be wholly consumed is fit to use in the process of cooking, and any chimney which creates a draught upon the fuel when in the process of combustion, like the ordinary chimney of a house, is worse than useless, since it wastes the greater part of the heat generated from the fuel.

The true science of cooking consists in the regulated and controlled application of heat by which flavors are developed and the work of conversion is accomplished. For this purpose a quantity of fuel is required which is almost absurdly small compared to the quantity commonly used.

Compare the ordinary method of using fuel for cooking with the scientific use of fuel for the development of power in the steam-engine.

The sheet of lightly sized linen paper abstracted from the unused part of an old ledger, on which I am now writing the first draught of this essay, measures $13'' \times 9'' = 117$ square inches, and weighs half an ounce. In solid form it measures half a cubic inch. If consumed under the boiler of the modern marine steam-engine such as is used in the freight-steamers that carry our wheat to England, two sheets of this paper in a solid form would be equal to seventy-one per cent of the calorific value of a cube of bituminous coal of the same size, and would drive a ton of wheat and its proportion of the steamship $1\frac{4}{10}$ miles on the way from the producer to the consumer at the present standard of power developed from coal. Yet not over twelve per cent of the actual power of the heat which this scrap of paper will yield would even then be actually converted into work. A cube of pure wood-pulp of the same size will do the same work. On the other hand, wood-pulp until ignited is the best available non-conductor of heat; I therefore build my ovens in greater part of wood-pulp prepared so as not to ignite at any degree of heat which is necessary for cooking; but even in my oven it requires one quart of oil, measuring a fraction under fifty-eight cubic inches, to cook fifty to sixty pounds of bread, meat, and vegetables in four successive charges occupying two hours each. Compared with the application of heat to the development of power, even my oven must be utterly condemned as wasteful of fuel; but compare my quart of oil with the hodfuls of coal that would be required to cook sixty pounds of food in the common range or stove, and then what is the verdict?

I now venture to submit the data of a dinner prepared by myself, but little out of the usual course, as an example of the common practice in my own family, and of what may be done substantially with one lamp. The dinner was provided for my own family of seven persons, with five guests, and it also sufficed for four servants—sixteen in all—with something left over. My summer kitchen is fitted with a cooking-stove, as it is more convenient to use the top of the stove, heated with hard-wood chips, for boiling water, heating the soup, and boiling potatoes, than it is to use a kerosene-oil stove of the common kind; on this stove the soup made the day before in the Aladdin cooker was reheated, the potatoes were boiled, and the hot water was provided.

The dinner cooked in the Aladdin oven consisted of three to four pounds of fresh blue-fish, just caught, cooked in imitation of broiling, one hour; six to seven pounds leg and loin of lamb, roasted one and three fourths hours; three tame ducks, weighing about seven pounds, roasted one hour; squash cooked in its own

juice, with but very little water, one and three fourths hours; stuffed tomatoes cooked three quarters of an hour; a large apple *soufflé* pudding baked one hour.

The oven having been previously heated one hour, the lamb and the squash were first put in; later the fish was added; while these were being served, the ducks and the pudding were being cooked; the use of the lamp for the whole service was four hours; the oil consumed, one pint, cost less than two cents; the cook's estimate of the coal which would have been required for the dinner had it been cooked in the large stove which has been used in other years, at one and a half to two ordinary hodfuls.

This was an every-day dinner, to which my guests had been invited in order that they might test our common practice.

I assume that the effect of heat upon food material is what may be called chemical conversion, accompanied, when the heat is applied at a low degree only, by partial evaporation of water, but when applied at a high degree, by partial distillation of the juices, by the cracking or dissociation of the fats, and by the diffusion of the volatile parts of the food in bad smells with loss of flavor and waste of some of the nutritious properties of the material. If the cracking or dissociation of the fats is carried to a point which is very common in iron stoves and ranges, the residuum of the fat becomes very indigestible and positively unwholesome. When rightly cooked and not cracked or dissociated, a certain portion of fat is absolutely necessary to adequate nutrition. Is it not true that we take into our stomachs a great deal too much fat, and that it is eaten in the most injurious form?

The preparation of the coffee-berry is the most familiar example of the development of its properties by the right application of heat. If the berry is dried, ground, and made into an infusion without being roasted, no true or drinkable coffee can be made from it. If overheated and burned, the infusion is acrid and unwholesome. But when the berry is carefully roasted and ground, the infusion makes true coffee. The flavor and other properties are the actual product of the heat, when scientifically applied. The flavor of the pea-nut is developed in the same way. In the treatment of grain, none yields so great a difference in flavor, according to the method of cooking, as the meal of maize or Indian corn; but I find the wheaten bread, whether made of whole or of bolted flour, yields a much finer flavor when baked two or three hours in my pulp oven at 250° to 300° Fahr., than when quickly baked in a common stove or range in one hour at an unknown but admittedly much higher degree of heat. The flavors of the white kinds of fish, such as cod, haddock, flounder, scup, and the like, which are much impaired by the ordinary methods of cooking, are very finely developed when slowly cooked in my

oven; and, lastly, all kinds of meat and poultry develop their respective flavors in the most appetizing manner when roasted in my pulp oven at such low degrees of heat as not to give off any smell or to dissociate any of the volatile elements of the juices or fats, while for game nothing can equal it. Quail and partridge come out rich, juicy, and of almost too full a flavor.

I have frequently served dinners or lunches of four or five courses—soup made the day before, reheated; fish, meat, game, potatoes, cauliflower, asparagus, onions, tomatoes, and custard pudding—all cooked in the same oven at the same time in the dining-room, and served from the oven to the table in the china or earthen dishes in which each had been cooked; the only difference between one dish and another being in respect to the time in which it had been subjected to the heat of the lamp or lamps, yet without the least flavor or taint being carried from one kind of food to the other.

It will be apparent that, if cooking can be done in this way, the whole art will consist in preparing the food according to written or printed receipts, and in determining the degree of heat and the time to which these dishes should be subjected. No watching is needed, and indeed none is possible without danger of cooling off the oven by opening it too often. Of course, it is better to use two ovens than one, devoting one to meat and fish, served by a lamp of moderate power for the right period of time, and the other served by a lamp of higher power for cooking vegetables, puddings, and pastry.

My Aladdin ovens, so called, are adapted to methods of cooking corresponding to broiling, roasting, baking, and braising; but they can also be used for boiling and simmering.

My Aladdin cooker, so called, in which the heat is conveyed through water, is devoted wholly to boiling, stewing, and simmering, especially the latter. I neither attempt nor desire to *fry* anything in either kind of apparatus. About nine tenths of all the cooking of my somewhat large family has been done with this apparatus for nearly two years, and I also have an office lunch-room for the use of about twenty employés, in which no other apparatus is or can be used. My summer kitchen at my sea-side house is fitted with a grill which is very seldom used; it proves to be most convenient to use the cooking-stove, heated with hard-wood chips, for boiling the water for tea and for occasional frying.

My winter kitchen is a large one, and it depends upon the range for warming it. The range, therefore, continues to be used to some extent for cooking, mainly for preparing breakfast, but I contemplate substituting a special stove without any oven, which will heat the room with much less coal, the top of the stove being fitted for cooking in the ordinary way. Neither the oven of the

stove in summer nor of the range in winter are now used for cooking; therefore, the kitchen is never overheated and the food is never spoiled. We have occasionally failed to cook a large joint of meat for a sufficient time, but we have never spoiled a dish in the process of cooking since the pulp or jacketed oven was adopted.

What, then, are the simple principles of the science of cooking? I think they may be stated in a few very plain terms:

1. The heat should be derived from fuel which can be wholly consumed or wholly converted into the products of complete combustion without any chimney except that of the lamp or burner. The fault with coal, especially anthracite, is, that it is not evenly or fully consumed; hence the need of a chimney to take away the gases developed and not wholly consumed; but the chimney also carries off the greater part of the heat. It is very evident that the crude combustion of coal and the direct application of the heat generated will ere long give way to more scientific methods of consuming the gaseous products and of deriving the heat from the final combustion of the gaseous products in all arts. In the matter of cooking, kerosene-oil burned in any one of the types of lamp which have a central duct to convey oxygen from below to the inner side of a circular wick, when properly trimmed and served with well-distilled oil, gives substantially perfect combustion.

The same may be said of illuminating gas when used in one of the burners of the Bunsen type which supply an excess of oxygen and yield the blue flame.

The combustion of oil and of gas can be brought under absolute control by gauging the size of wick or burner to the work to be done.

2. The oven in which the food is to be subjected to this measurable and controllable source of heat must be so constructed that the heat imparted to it may be entrapped and accumulated up to a certain measure or degree and then maintained at that temperature without substantial variation until the work is done. This can be done by jacketing the oven in a suitable way with material which is incombustible and also a non-conductor of heat.

3. There should be no direct communication between the true oven or receptacle in which the food is placed and the source of heat, lest the products of incomplete combustion should sometimes taint the food, and lest the food should be exposed to being in places burned or scorched.

These three conditions are all accomplished in the two somewhat crude and probably incomplete inventions which I have named the "Aladdin Cooker" and the "Aladdin Oven," in both of which the heat derived from common lamps, such as are used for

lighting, may be stored or accumulated so as to do the work of cooking in a very perfect manner. In the cooker the heat is imparted to water in an attachment to a metal-lined wooden box corresponding to the water-back of the common range or stove, and the work is done by the contact of the hot water with the outside of the porcelain vessels in which the food is placed, or by the steam generated when the water is heated to the boiling-point.

In the oven a column of heated air is carried from the chimney of the lamp to the inside of an outer oven made chiefly of prepared wood-pulp, but outside of the inner sheet-iron or metallic oven in which the food is placed, which inner oven is separately ventilated.

I do not claim any originality in these simple principles or in the idea of jacketing an oven with non-conductors of heat. All these matters are well understood by every intelligent stove-manufacturer, but it is practically impossible for any one to apply them in making stoves such as will meet the demand of the market, for two reasons:

1. The greatest demand for stoves is that of people of very moderate means, who are too much controlled by the price in making a choice, making the common error in confounding cheapness with low price, an error which leads to great waste not only in the matter of stoves but in many other ways.

2. The absolute and imperative preference of the public for a stove in or upon which the work can be done very quickly.

The custom of cooking quickly is in part a matter of choice, and in part due to the necessity to which a great many working people are subject to cook their meals quickly or else to go without hot breakfasts and dinners.

Another great obstruction to improvement in the art of cooking is the almost universal misconception that the finer cuts of meat are more nutritious than the coarser portions, coupled with an almost universal prejudice among working people against stewed food. This prejudice is doubtless due to the tasteless quality of boiled meat; boiling toughens each of the fine fibers, and deprives the meat almost wholly of its distinctive flavor.

All these blunders and misconceptions must evidently be removed before any true art of cooking can become common practice.

The more necessary, however, does it become to invent apparatus in which meat can only be simmered and can not boil, as in the Aladdin cooker, and also to invent a stove or oven in which neither meat nor bread can be overcooked, dried up, or rendered indigestible by too much heat, as in the Aladdin oven.

Next, people must be persuaded that a better and more nutritious breakfast can be made ready to eat, as soon as the family

are out of bed, by putting meat stews, oatmeal, brown bread, and many kinds of puddings, into the cooker, and simmering all night by the use of a single safe lamp, than in any other way.

People must be taught that the dinner can be put into the oven when both husband and wife go to the mill to work, and so treated that it may be found perfectly cooked at noon, without requiring any attention in the interval.

People must be taught that the best of bread, raised with good yeast, can be mixed and kneaded between 12.30 and 1 P. M., placed in a bread-raiser, which will raise it ready for the oven at 6 or 7 P. M., and that this bread may be perfectly baked in two hours by the heat of the evening lamp, which at the same time serves to give light for reading or sewing.

All this can be accomplished with my crude apparatus, but, until some skillful stove-makers take up these inventions and make the ovens in large numbers at low cost, my own efforts must be directed mainly toward ameliorating the condition of the rich, saving the houses of the well-to-do from the heat and smell of the present bad methods, and in this way creating a demand for my ovens which, while made in small numbers by hand-work, are too costly for general use, although in an ordinary family they will pay for themselves in six months.

I have ventured to call the attention of the Public Health Association to these matters, because I have been led, by the study of the statistics of the cost of subsistence, to certain conclusions which are wholly in the line of your work.

I venture to ask you if it is not a fact that bad and wasteful methods of consuming food are not a most potent cost of inability to work to the best advantage? Are they not more promotive of disease, and, in fact, a more subtle cause of want in the midst of abundance, than even the waste on fermented and spirituous liquors?

From my own observations, I am of the opinion that dyspepsia is a cause of more disability than intemperance, although this proposition is not capable of statistical demonstration.

Material life consists in the conversion of forces, or in the application of material products, to the supply of the necessities of life. In the line of absolute necessity food comes first, clothing next, and shelter third. The supply of the materials for meeting these needs of the body is superabundant; comfort and welfare depend upon the relative proportion of the materials used, or upon the direction which may be given to the conversion of these forces. The result of each year's work is a given product; whether that product shall be adequate or otherwise depends almost wholly upon individual intelligence. In respect to the great majority of all who perform the actual manual or mechanical work of produc-

tion, if the expenditure for food and drink is unduly large, then either clothing or shelter must be restricted; a small part of the waste of food, on which half the income is spent, might, if saved, enable the family to double the expenditure for a dwelling-place. It follows that the most difficult question with which practical reformers are called upon to deal, viz., that of providing more ample and comfortable dwellings, may be solved by altering the conversion of the present product, even if that may not be increased, so that what is now in part wasted on food and drink may be spent for better shelter, and yet the family may be more fully nourished than at present. I do not claim absolute accuracy for the following proportion of expenses in workingmen's families, but I am quite sure they are near enough to the mark to serve as an example.

In a family of five adults, or of four adults and two children ten or under, making an average family of five persons, in which one half the income is spent for food and fuel, twenty-five cents a day per adult being spent for food, the corresponding average expenditure per adult:

For clothing will be	7 to	9	cents.
For liquor it may be	2 to	4	"
For sundries it will be about		5	"
And the remainder for rent or shelter, if no liquor is used	9 to	11	"
If liquor is used	7 to	9	"

Now, I think it is very safe to put the waste of food material at twenty per cent, or five cents a day; if this misspent force and one half the average cost of liquor, or two cents a day, could be converted into shelter—that is to say, to providing a more ample dwelling by either buying or leasing—it would suffice to enlarge the present quarters by one half to three fourths. Five cents a day per adult comes to $1,000,000,000 or more a year, counting two children of ten or under as equal to one adult. But the greater benefit which would come from a true art of preparing food would consist in the increase of the productive force of the community, so that the provision for dwelling might be increased both absolutely and relatively. I might add another treatise to this, on the waste of force in bad building and from the common practice of what I have named the art of combustible architecture; but time will not serve. Suffice it that the product of this nation is more than ample for the abundant subsistence, the adequate shelter, and the complete clothing of every family in it; yet we witness want in the midst of plenty, because we waste enough to support another nation at the standard of French economy and thrift, especially in the matter of food.

I may now venture to call your attention to some of the very subtile points which are brought out by the statistical investiga-

tion of the food question. I suppose that there is no kind of meat which is consumed so generally or in such large quantity as pork; yet, according to the chemical and physiological data, the conversion of Indian corn into pork, at the rate of one thousand pounds of corn to two hundred pounds of pork, results in a waste of practically all the protein and nearly all the starch, and gives a residuum of fat of which most people get too much in the other kinds of food which they consume. Yet it would be useless to try to abolish pork from the common dietary. I sometimes wonder if the Hebrew lawgivers were not good economists when they condemned the use of pork, or whether they were guided wholly by sanitary considerations.

Again, the present crop of wheat calls for fifty thousand tons of twine for binding it upon the self-binding harvester; the cost of binding wheat by hand was five to six cents per bushel, and it required a small army of agricultural tramps who charged almost any price when needed to do this work. The self-binder reduced this charge to not exceeding one cent and a half per bushel. This reduction, which finally took effect two or three years before the resumption of specie payments in this country in 1879, was one of the principal factors in enabling us to export wheat profitably and vastly in excess of anything previously known; and it was upon the margin of exports over imports, consisting wholly of wheat, that we were enabled to import gold in sufficient measure to resume specie payment. Yet this all turned on tying a knot by the machine instead of by hand.

Again, I will present to you my diagram of the loaf of bread, which I have frequently used in other ways. You will observe that, with wheat at about the present price, bread can be made and can be sold in a very large way at three to three and one half cents per pound; but if the bread is distributed in the customary manner by way of small shops or by delivery on the part of the bakers themselves, you will find that the price of bread ranges from five to eight cents a pound, according to the quality.

Now, in this oven made of paper, any person of ordinary intelligence who is willing to devote twenty minutes to kneading bread —which requires more muscle than it does mind—then placing it in the bread-raiser, following a certain rule, taking it out at a given time and putting it in this oven over this lamp, can make better bread at three to three and one half cents per pound than any baker's bread which can be purchased. Here are samples of the bread; you can taste it for yourselves. I devoted two evenings to learning how to make bread; and I baked these loaves, some of which I made myself, by the heat of the evening lamp which lighted my library table while I was reading my evening paper.

I have said that a saving of five cents per day *per capita* might

Charlton, Iowa. October, 1883. Glyndon.

No. 1.	$405 00	No. 1, $405, is the price which the farmer receives in Iowa, at 90 cents per bushel; $360, in Dakota, at 80 cents per bushel.	$360 00	No. 1.
No. 2.	$117 50	No. 2, $117.50 is the charge made by the railway for moving 450 bushels of wheat from Charlton to Chicago, and 100 barrels of flour thence to Boston, $197.50; Glyndon to Minneapolis and thence to Boston, $82.25; cost of railroad service at 70 per cent., $138.25 of the total charges.	$197 50	No. 2.
		$35.25 profit, at 30 per cent., $59.25.		
No. 3.	$50 00	No. 3, $50, cost of milling.	$50 00	No. 3.
No. 4.	$45 00	No. 4, $45, cost of barrels.	$45 00	No. 4.
No. 5.	$30 00	No. 5, $30, merchant's commissions and cartage in Boston.	$30 00	No. 5.
No. 6.	$200 00	No. 6, $200, cost of labor in making 100 barrels flour into bread in a small bakery.	$200 00	No. 6.
No. 7.	$210 00	No. 7, $210, cost of fuel, yeast, salt, etc., used in converting 100 barrels flour into bread.	$210 00	No. 7.
No. 8.	$1,057 50	No. 8, final cost of bread ready for distribution, average 3½ cents per pound; varying a little with the quality of the flour and the quality of bread. Iowa flour yields 270 and 290 pounds per barrel; Dakota flour yields 280 and 300 pounds per barrel.	$1,092 50	No. 8.
	$562 50		$587 50	
No. 9.	$1,620 00	No. 9, the price which the poorer people of Boston pay for poor bread, made from a medium grade known as "baker's flour," averages not less than 6 cents per pound, which makes the cost of distributing 100 barrels of Iowa flour baked into bread, No. 9, $562.50, and 100 barrels Dakota flour, $587.50 at the minimum yield of 270 and 280 pounds bread to the barrel. When either kind of flour is treated so as to yield 300 pounds bread to a barrel and sold at 6 cents per pound, $180, or $120, is added, and the final cost of the bread to the consumer is at the rate of $18 per barrel of flour, No. 10.	$1,680 00	No. 9.
	$180 00		$120 00	
No. 10.	$1,800 00		$1,800 00	No. 10.

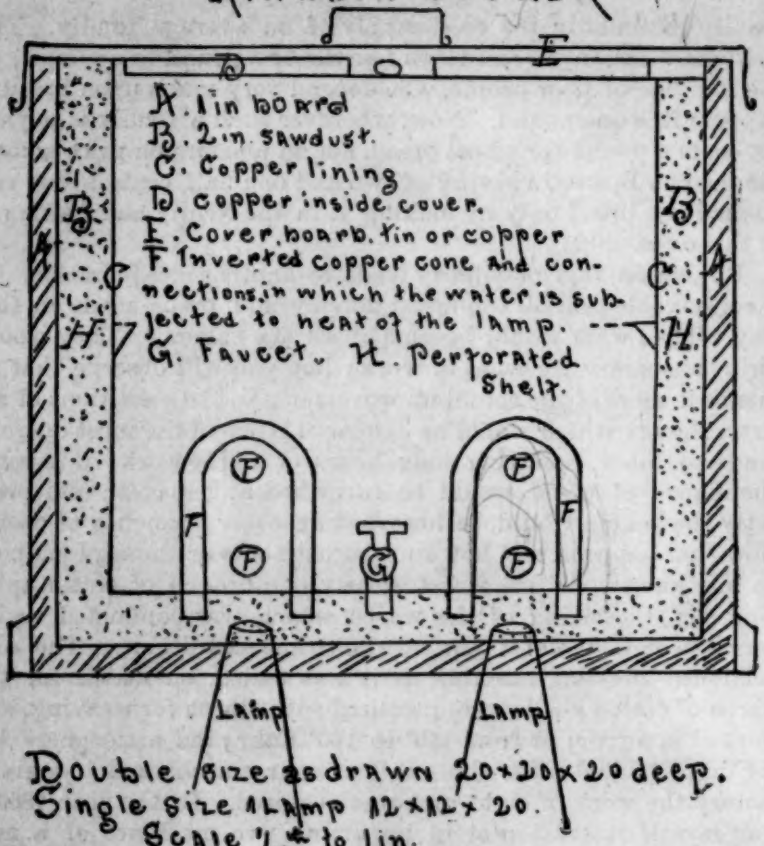
The foregoing table was made in 1883, when wheat was worth ninety cents a bushel on the far Western farms. The price of wheat, and the charges for transportation and milling, are now lower. The cost of distributing bread is now greater in proportion than it was in 1883.

readily be made in the food-supply of an average family. The customary ration is from three fourths of a pound to a pound; in the families of poor people, who depend very much upon bread, I suppose it is one pound. Now, wherever such a family is paying six cents a pound for wheat bread, not an uncommon price among the poor in Boston, a saving of two and one half cents a day can be made on bread only by making it in the family and baking it in this oven.

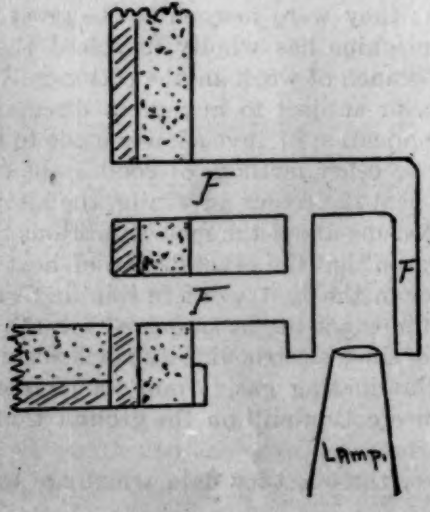
But, again, this possibility leads to another consideration. It is conceivable that all the bread may by and by be made in this way. Then what would become of all the bakers? They would for a time suffer for want of work; but you will observe that in this as in most of the actual improvements in the conditions of society, the art which would be displaced is one of the most onerous kinds of labor, requiring long hours of night-work; a greater abundance of bread would be furnished at less cost; and presently the bakers would be absorbed in other branches of work. How that happens, and how such adjustments are made, I suppose no one knows. There was formerly one branch of cotton-spinning, viz., the sizing of the warps, which was conducted under very uncomfortable if not unwholesome conditions. The old-fashioned dressing-machine, as it was called, on which all the warps of cotton goods were prepared with starch for weaving, was worked in a room at from 110° to 120° Fahr., the atmosphere being impregnated with the smell of sour starch; and in a given factory the work of eight men was required. In the year 1866 I was myself instrumental in importing two machines of a new kind from Great Britain; these machines were operated in a light, cool, and well-ventilated room; a man and a boy did the work of the eight men. What became of the other seven men? I never could trace them; they were merged in the great body of workmen. The new machine has wholly displaced the old one; and there is now no branch of work in the cotton-mill which is considered injurious, or subject to any great discomfort. In fact, when the final application of invention is made to the cotton-factory by using ice or other methods of cooling the air in summer, as we use fuel to heat the rooms in winter, the atmosphere of the cotton-mill will become about the most salubrious that can be obtained, for the reason that the exact degree of heat and humidity which is called for in the best work in spinning and weaving is consistent with the exact degree required for the health of the human body; and since electric lighting has displaced the noxious vapors of illuminating gas, it may soon become possible to secure workers in a cotton-mill on the ground that a cotton-mill is the best sanitarium.

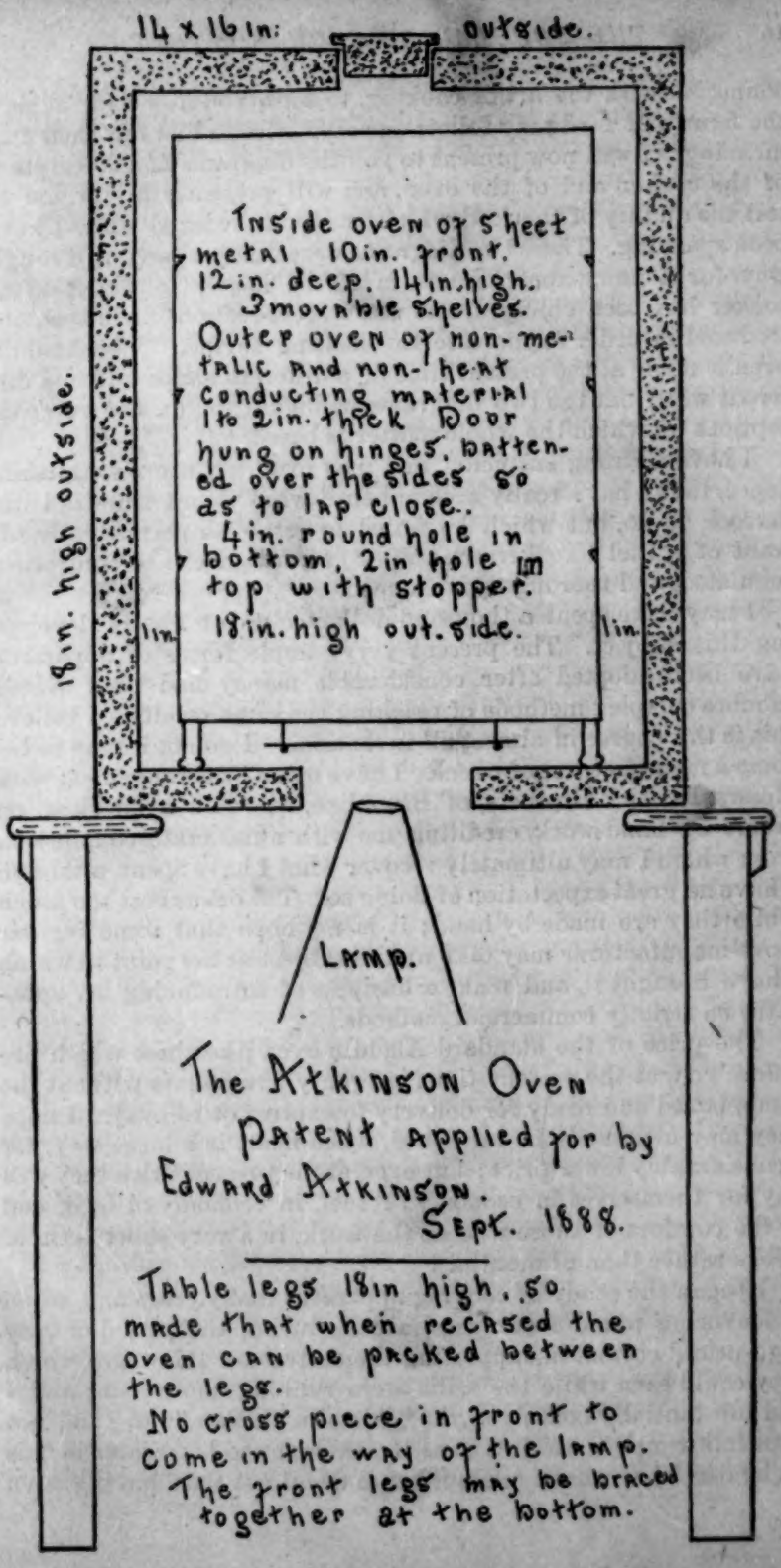
I have given you these last few data, which are not immediately

"ALADDIN COOKER"



Double size as drawn 20×20×20 deep.
Single size 1 Lamp 12×12×20.
Scale 1/10 to 1in.




14 x 16 in: outside.
Inside oven of sheet metal 10in. front. 12in. deep. 14in. high. 3 movable shelves.
Outer oven of non-metalic and non-heat conducting material 1 to 2in. thick Door hung on hinges. battened over the sides so as to lap close..
4in. round hole in bottom, 2in hole in top with stopper.
18in. high out. side.
1in.
1in.
18 in. high outside.
Lamp.

The Atkinson Oven

Patent applied for by Edward Atkinson.

Sept. 1888.

Table legs 18in high. so made that when recased the oven can be packed between the legs.

No cross piece in front to come in the way of the lamp.

The front legs may be braced together at the bottom.

connected with the art of cooking, to show you how "far afield" the figures of food may follow one who tries to find out their full meaning. I will now present to you the diagrams and description of the cooker and of the oven, and will presently invite you to test the quality of the food which has been prepared while I have been speaking. These two diagrams were first prepared in a rough way for a newspaper; the form of the heater to the Aladdin cooker has been changed, and some cross-sections have been introduced in order to increase the heating surface. The Aladdin oven is made at the present time of a different shape and in a different way; but the two diagrams will show to you the two conceptions on which the whole matter is based.

I have a strong suspicion, or I may even say a growing confidence, that I have really accomplished what Count Rumford undertook to do, but which he failed to establish permanently for want of a fuel like kerosene-oil or gas, which can be controlled, regulated, and thoroughly consumed.

I may have spent a thousand dollars more or less in developing this subject. The present very simple forms of apparatus have been adopted after considerable money had been wasted in more complex methods of reaching the same results. I believe this is the course in almost all inventions. I do not intend to become a manufacturer of ovens. I have made an arrangement with Messrs. Kenrick Brothers, of Brookline, who now make them on orders by hand-work, crediting me with a moderate commission from which I may ultimately recover what I have spent, although I have no great expectation of doing so. The ovens cost too much while they are made by hand; it is my hope that some regular stove-manufacturer may take up the subject at the point to which I have brought it, and make a business of introducing my apparatus on strictly commercial methods.

The price of the standard Aladdin oven like these which are before you, at the present time, is twenty-five dollars without the lamp, boxed and ready for delivery to express or railway. I hope they may ultimately be furnished, when made in a large way, for a considerably lower price; but even at the present price they will pay for themselves in economy of fuel, in economy of food, and in the comfort of those who do the work, in a very short term of weeks rather than of months.

I began the study of cooking apparatus many years ago, when endeavoring to aid factory operatives, during the period of very high-priced cotton, in supporting themselves on the wages which they could earn while the mills were running short time; and I had substantially conceived the "Aladdin Cooker," but I did not then follow up the subject so as to enable me to boil water in this apparatus by means of a lamp, kerosene-oil not then having been

introduced for such purpose. Moreover, I was under the old superstition that it was necessary to have a heat at or above the boiling-point in order to cook at all. Even Count Rumford found out by accident that meats could be cooked at a lower degree; and it was not until I happened to read Dr. Mattieu Williams's "Chemistry of Cookery" that I was led to develop the Norwegian cooking-box into the cooker with the heating attachment.

Perhaps I unwisely gave way this idea or conception which I might have patented: I had the impression that it would be adopted more rapidly; but the public have become so accustomed to the patent system in this country as to make it almost impossible to give away even an idea. I doubt if this is altogether a wholesome condition, when manufacturers wait so long for the protection of a patent before undertaking to make a good thing on a commercial scale. Nevertheless, one must accept the fact, and the cooker has not been taken up by any manufacturer. Warned by this lesson, I applied for a patent on my first "Aladdin Ovens," which were made wholly of metal, the outer oven being packed with non-heat-conducting material; but on this application I failed; this identical apparatus had been invented fifty years ago, the heat being derived from a pan of charcoal, and the patent had expired; of course, the charcoal did not meet the necessary conditions. I found, however, that the oven made wholly of metal packed with carbonate of magnesia or fossil meal would be very expensive; moreover, the outer metal skin wastes a great deal of heat. I then experimented with various compounds, and finally adopted the material of which these ovens are made, known as "*indurated fiber*," or paper pulp, prepared in a certain way under a patent and baked at a high heat. I applied for a patent on an oven made in this way, but the mere substitution of the pulp for the metal did not suffice to give me the patent asked for. There is therefore no patent on the construction of either of these devices. The names "Aladdin Cooker" and "Aladdin Oven" are my trade-marks, on which I may hope to hold a certain control, so that the ovens shall be made of safe material, incombustible at any degree of heat required for the work, and from which control I may possibly recover the money which I have spent on my experiments; if I do not, it will be my contribution to the public service; and if by this contribution I can do away with even a small part of the waste of good food material and with a small part of the indigestion caused by bad cooking, I shall consider myself fully compensated.

Under such conditions I may perhaps venture upon the ordinary method of citing the testimony of some of the few persons who have bought these ovens and who have made use of them. I will first give a copy of a letter from an elderly lady who visited

my office with her daughter; the latter was very skeptical as to success in working my apparatus; the oven was, however, bought, and has been in use during the past summer; her testimony in regard to it is as follows:

I am glad to tell you that I like the Aladdin oven very much indeed. My dinners for the last three months have been cooked in it with success and economy, and the kitchen never overheated. It saves material, fuel, and labor, as well as heat. It is an immense comfort as well as economy. It bakes bread and cake nicely, and we have only used coal for laundry purposes. I wish it could be produced at a cheaper rate, though I would not lose mine for twice its price.

Another certificate I may venture to give from another lady who has tried the apparatus, as follows:

1. In respect to economy in the use of material for food: All remnants of food can be served again without drying or losing any of the fresh flavor. With any skill, therefore, "made dishes" can be produced until the first material is used up.

2. In respect to comfort of the kitchen: It goes without saying that a room in which only a lamp is burning is cooler than one with a fire in an iron stove.

3. The cook says it is much less work; but I find they sometimes from force of habit throw the fuel into the stove and cook there rather than take the trouble to use the oven.

Lastly, general conclusions: It is of inestimable value in warm weather, and saves two hods of coal a day when it is used half the day. For an apartment-house or in small kitchens it will be a great boon. With an intelligent, care-loving woman it will go much further and do better work, of course, than with the ordinary cook, though it is so simple that any one can use it.

In a third letter, the testimony is as follows:

My general conclusions in regard to health and appetizing conditions are: Bread from the oven is much more wholesome than from the range, because of the slow, even, and thorough baking. Meats are more wholesome, because the juices are entirely preserved and the fats not overdone. The greatest advantage, perhaps, is the possibility of so regulating the temperature as to preserve fine and delicate flavors at the same time that the most wholesome results are secured.

Finally, I am permitted to give the following extract from a note from Mrs. Ellen H. Richards, whose excellent work in industrial and household chemistry is doubtless well known to you.

I submitted the early types of my oven to an investigation which was conducted under her direction by Miss Marion Talbot, whose thoroughly scientific report upon the diffusion of heat and other matters encouraged me to go on, and was wholly consistent with my own experiments and with all the evidence which I have since obtained. This latter report is too long for inclusion in the present address. Mrs. Richards's present statement is as follows:

It seems to me that the mission of the Oven and Cooker is in the ideal life of the twentieth century, as shown by Bellamy. That is, when the people of the middle classes, as we know them now, shall pay attention to the question of food,

and when the present kitchen and cook shall be abolished; when in each section we can buy a chicken ready dressed for the oven, a fish all washed and stuffed; when we can get bread and pastry such as we like; in short, when we have places like the Women's Exchange on Boylston Street, in each ward or village—then we shall use the Aladdin Oven, to dispense with kitchen and cook, but until then it will come into use only as an accessory, and especially in summer.

Unskilled hands can get much better work out of it than out of an ordinary range, chiefly because it can not be overheated, and things can not be burned to a crisp.

Our people need to learn what is to them a new art, the delicate flavoring which is brought out only by time—that is, by *slow* cooking.

When a stew deliciously flavored is to people better than *crisp* beef, then the oven will go; but the majority of our people are still barbarians in taste, and it will not do to claim too much.

I am sure that the conditions of slow cooking are very favorable to ease of digestion, and that the digestibility of many things is very much increased.

I am sure that economy lies in the use of material which is much less expensive, but here again we must learn to like the result.

In summer the saving of fuel is very great; in winter most people need the fire—often the kitchen is the only fire.

Educated housekeepers with their own hands must work it up. Servants will not learn anything new unless working with the mistress.

I believe the idea is destined to give a much-needed relief to multitudes of overworked women, just as soon as they can be convinced of the possibility of relief.

I may venture to subscribe myself, especially in this presence, by the use of the same words which I once adopted as a motto in my treatise on the "Missing Science of Cooking." I am—

COCTOR NON DOCTOR.

OLD AND NEW METHODS IN ZOÖLOGY.

BY M. H. DE LACAZE DUTHIERS.*

PERMIT me to begin my address by a reminiscence of the origin of this Association, which has haunted me from the moment when you did me the honor to make me your president. It was in July, 1871, when, as we were leaving the Academy of Sciences, Wurtz, taking me by the arm, in his friendly way, said: "Come to my house to-morrow evening; I wish to talk with a few of my friends concerning a scheme which I should be very glad to see carried out." MM. Delaunay, Claude Bernard, Decaisne, and I met at Wurtz's house in the rue Saint-Guillaume on Tuesday evening, and held what we may call the first meeting of the Association. As the last survivor of the company I can not refrain from recalling that intimate interview at which our Associa-

* From the presidential address at the French Association for the Advancement of Science.

tion was born. I can still see Wurtz, with captivating animation and almost feverish activity, pacing the floor with precipitate steps and picturing to us what he thought our society ought to be—and what it has become. He pointed out the priceless advantage to be derived from these meetings, to be held in all parts of France. "We shall," he said, "seek out modest local students living far from the center to meet us and make known the results of their investigations; we shall draw the most timid of them into the scientific current, and shall thus be able to exalt our beloved country in the eyes of the scientific world." Now, the only witness of that first and modest meeting, I believe that I am the interpreter of the feeling of you all in paying one more tribute to the memory of these our first and illustrious co-laborers.

In addressing you I purpose to inquire what zoölogy was, what it is with some, and what it should be. The science of animals of a hundred years ago and that of to-day resemble each other but little. Comparing them and seeking the cause of the great differences, we recognize a few leading facts which I have selected, and of which I will speak. In the former time, when so many reforms were in preparation, and when excited minds were looking for other objects on which to utilize their activity than our sciences, always calm and independent of revolutions as they ought also to be of politics, natural history held but a small place in men's thoughts. In 1789 Linnæus and Buffon had only recently died, and their names were still radiant with the splendor of their living brilliancy; they dominated as absolute masters, and summarized in themselves all of zoölogy. Yet in their minds and works they resembled each other but little. Linnæus, precise, methodical, a classifier first of all, brought order and clearness into the minutest details of the things of nature, and, as he proposed a concise and easy language, his influence became so preponderant that Haller complained of his tyranny. If the reform of the scientific language which Linnæus worked out imposed itself with such force, it was because it answered to one of the needs of the moment. The simplicity, facility, and especially the opportuneness of his nomenclature were the cause of its great success; and it should be added that its value was so great that we have not yet sensibly departed from the rules on which it was founded.

The opposite of Linnæus, Buffon took pleasure in broadly drawn descriptions and pictures; and, when he treated of general considerations, he animated them with a powerful inspiration. A profound thinker, regarding science from an elevated point of view, he engrosses and subjects us. Who among us does not recollect the enthusiasm with which he has read some of the passages in the "Epochs of Nature"? By his reasoning and in the conse-

quences of the observations which he interpreted, Buffon sought rather to foresee what should be or ought to be, than to fix what he ascertained. He was thus often in advance of his time, and the elevated considerations to which he gave himself were within the grasp of only a small number. Linnæus, on the contrary, described, simply and clearly, what was. With such qualities these two men would often be far from agreeing; and we might apply to them the distinction, which had not yet been expressed, between the school of facts and the school of reasoning. While Linnæus and Buffon thus summarized in themselves all of zoölogy, although from different points of view, their labors lacked a basis the imperious need of which was universally felt. It was already beginning to be understood that the study of the habits, geographical origin, and external characteristics of animals was not enough. At that moment Cuvier appeared. The reform which he introduced in zoölogy was very important, and his work, on the "Animal Kingdom distributed according to its Organization," produced a momentous impression. His great fame, like that of Linnæus, is due to the fact that the modification he made in zoölogical studies corresponded to a certain want, and was a necessary reform that came at the time when it was most needed. Zoölogists of the classifying kind, who occupy themselves only with the externals of animals, have been compared to librarians who arrange their libraries according to the backs or covers of the books, without regard to what is within them. It was Cuvier's great merit that he saw clearly that to reach a truer knowledge of things we must not only be acquainted with the names and external features, but with the internal characteristics as well. To that end he introduced the anatomical idea into the history of animals. In doing it he rendered the greatest service to zoölogy; and to this, too, must be attributed his great success, which was equaled only by that of Linnæus, and also the great reputation in which French zoölogy shone at the beginning of the century. To-day, even those zoölogists who criticise Cuvier the most, nevertheless follow his precepts. We can not apply the same standards of criticism to his work that we would insist upon in judging a work of to-day. To make an equitable estimate, we should put ourselves back to his time, and take account of the gaps in the knowledge of that period, and of the insufficiency of the means which observers could control. It will soon have been a hundred years since Cuvier's work was performed. In that time a great many discoveries have been made, and many conquests have been achieved to cast a new light on questions which were insoluble then.

Zoölogy remained for a long time at the point to which Cuvier led it; and we have to come to the middle of our century to see new ideas brooding and bringing about great modifications in the

direction of studies or in some of the branches of the biological sciences. I purpose to supply only a few examples of them. I recollect that in 1855, when I was a professor at Lille, Mr. Huxley wrote to me that "we in England are all stirred up and much perplexed by the discoveries of M. Boucher de Perthes." The reference is, of course, to the interest that was aroused about the cut flints of Saint-Acheul and the famous jaw-bone of Moulin-Quignon. English men of science and geologists came to Amiens, lively discussions took place, a committee of Frenchmen and foreigners was formed and proceeded to the spot to make official investigations. Some fraud and incredulity were mingled in the affair. A workman confessed to me, for a money consideration and a promise of silence, that he had himself fabricated one of the two specimens which I procured, and that it had not lain long enough in the bed to acquire the patina of the other. The point I desire to emphasize is, that the real thing that was discovered then, especially after the visit of the British investigators, was the books, the researches, and the new ideas of M. Boucher de Perthes, which had till then passed unnoticed. The beginning of the prehistoric studies, which have since attained so considerable development, may be dated from this time. Since the discoveries of Boucher de Perthes at Saint-Acheul, and those of Lartet and Christy in Périgord, a part of the history of man has been completely transformed; and geology, so far as concerns the most modern formations, has been subjected to the salutary influence of the new knowledge. What has become of the superannuated ideas that conceived fossil man impossible? What new problems, full of interest, have been presented since the remains were found in Périgord and other places of animals that no longer live where their bones are lying! How many interesting questions have resulted from the simple discovery of a reindeer-horn in a grotto of Eyzies; and what a long road we have gone over since then! Is it strange that the number of explorers has become great, and that liberal and often magnificent encouragement is given them? It would be ungrateful in this connection not to repeat the acknowledgment of our obligations to one of our members—M. Girard, of Lyon—who has bequeathed to our Association one hundred and seventy-two thousand francs to be applied exclusively to researches in prehistoric anthropology; the proceeds of which your committee is able to use this year for the first time.

The lively emotion produced by the discoveries of M. Boucher de Perthes had begun to subside, and researches were going on everywhere, when Darwin's first studies appeared in 1858 and 1859. These dates must always be memorable in the history of natural science, for they mark an epoch from which zoölogical studies entered upon a new course. The learned world, we might say,

revolted when Darwin's book appeared. Then enthusiasm, with all its exaggerations, succeeded the first astonishment; and in a little while, a reaction taking place, innumerable investigations were begun with an activity and a curiosity which the previously received ideas were no longer capable of determining. In the first spasm of enthusiasm the great naturalist's theory was called Darwinism; at a later period, dealing less in details and generalizing more, it was called Transformism.

It must be recognized that whatever measure of confidence we put in transformism, whether we accept it in its whole extent and with all its consequences, exaggerate it, modify it, accept it with amendment, or reject it, no one can doubt that it has provoked a truly extraordinary scientific movement. Both partisans and detractors, in seeking for proofs in support of their opinion, whether demanding its secrets from embryogeny, or digging into the strata of the earth in order to interpret the remains of organized beings which they inclose; all, whatever may have been their method, ideas, opinions, or even hostility, have contributed greatly to the progress of zoölogy. Thus we are far from the period of Linnæus, when the external character was everything; and from the period of Cuvier, when the anatomical idea and the study of the exterior were the only guides of the classifier. Now we investigate the connections of beings by going back from the existing to the primitive forms, or *vice versa*. We try to explain the varied forms under our eyes by the aid of the laws so happily formulated by Darwin. Evolution is encountered everywhere. Whether one be a transformist or not, he must bow and acknowledge the force of the tremendous bound which the impulse given by Darwin has caused.

There are, however, as Claparède has said, "terrible children" of transformism who are more anxious to make a noise around their name than to discover the truth. We must prudently distinguish from them the conscientious students who seek long, scrupulously, and painfully for precise facts in order to deduce from them consequences that will support their theories. These surely advance science, while the others often compromise it. The one thing to oppose to exaggeration, assumption, and enthusiasm is experiment. It is as mandatory to-day as in the preceding period were the reforms which I have mentioned.

While Darwin had an immense and legitimate success, the ideas of Lamarck, who more than half a century before him taught and published the same views on the mutability of species, were long forgotten. Our illustrious compatriot has been treated rather unjustly and severely. There are whole pages in the works of Lamarck containing the theory of transformation completely developed, to which Darwin has added nothing except to confirm

them. The minds of zoölogists were not prepared in his time to receive his ideas, and he had not the happy faculty of hitting upon that clear and precise method of statement that imposes itself and makes itself accepted by all. For a reformer to secure a following, his idea should be defined with dazzling clearness and precision, and achieve mastery by virtue of its seductive force. Darwin's exposition of the universal and constant struggle for existence, ending in the selection and survival of the victor, was so true and clear as to lead all readers into accord with it. Cuvier, they said, could reconstruct the whole of an extinct animal from a single bone. The thought spoke to the imagination of the masses; and when he laid down the principle that in an organism, as in an equation, the known terms may be made to give an unknown one, he commanded the admiration of a whole generation. Linnæus, who at a stroke reached the reform science was aspiring after, to rid itself of nonsense in nomenclature, and who found names to fit the occasion, became the tyrant of natural history. It was not possible for Lamarck to realize a similar success; and a comparison of his arguments with those which Darwin brings in support of the doctrine of changes in the forms of animals, and a reference to the epoch in which he wrote, will show why his ideas had to wait for the revelations of the English naturalist before they could be recovered from oblivion.

In view of the surprising discoveries to which the continuous study of the evolution of the lower animals has led, and of the direction of zoölogy under the influence of transformism into new ways, it is impossible not to recognize that experiment alone fulfills the requirements of the moment. It is only through experiment that the great questions of natural philosophy can be answered; that the discussions raised by clashing convictions, hazardous assertions, so-called philosophical doctrines, and venturesome syntheses too often lacking substantial bases, can be justly appreciated or solidly established.

The citation of a few instances will illustrate this assertion. Every one has noticed the gall-nuts on oak-trees, excrescent tumors produced by parasitical insects—the *Cynips*—which lay their eggs in the mother plant by the aid of a gimlet-shaped ovipositor. The young insect finds within this swelling all that it needs to support life, and quietly in it reaches complete development; and it can easily be caught as it issues from its prison. Entomologists have catalogued a large number of species and genera belonging to the family. In doing thus, they have followed pure and descriptive zoölogy, as it was in the times of Linnæus and Cuvier. Now, it has been found, after watching the evolution of these parasites, that all the genera and species have to be revised. Thus, for example, we find on the superficial roots of an oak-tree galls

of varied colors and sizes, the insects issuing from which are wingless. When the trial is made, they will be found incapable of reproducing the warts they came from; they are, besides, all females. Again, we may see, in the spring, the ends of the limbs of the same oak bearing greenish-red tumors, which naturalists have long called oak-apples. They are also galls from which *Cynips* issue; these too, like the others, are incapable of reproducing the swellings from which they came; but they have wings, and are both male and female. Here, then, are beings totally different, if we study them separately as they come out from their nests. Now let us follow the experimenter, first observing that the insect of the root has been called *Biorhiza*, and that of the apple *Teras*. The *Biorhizas* escape from the roots on which they are hatched, and raise themselves up slowly and painfully, having no wings, to the ends of the branches of the tree. There they lay unfertilized eggs, and cause, by piercing the twigs, the oak-apples from which the *Teras* issue. On the other side, the *Teras*, escaping from their apple, copulate, and the fertilized female descends to deposit her eggs in the roots. The *Biorhizas*, therefore, are hatched from the eggs of the *Teras*, and the *Teras* from the eggs of the *Biorhizas*. Here, then, are two genera wholly distinct in habits, organization, and external characters, which are nevertheless derived each from the other, and which zoölogically ought to form only one. How could M. Adler have discovered these facts, except by experiment? When we remark that the *Cynips* are relatively high in the animal scale, we are justified in believing that a very great number of similar surprising facts may yet be found among lower forms.

I can not refrain from relating another life-history which is almost a romance. There is a hard sandstone in Provence, interspersed with friable strata, in which burrowing insects construct their chambers. A kind of bee, the *Anthophorus*, makes nests there and fills them with honey, on which it leaves its egg to float; then, finally, plasters up its chamber. Instead of *Anthophores*, entirely different insects come out from these nests—*Sitaris*, belonging to a group very remote from the bees. Let us see how they manage to substitute themselves for the legitimate proprietor of the nest. In the autumn the impregnated female of the *Sitaris* deposits her eggs in front of the sealed galleries of the *Anthophorus*. The young are hatched from these eggs, and lie in front of the closed doors, and thus remain in a mass, mingled with the dust and rubbish of the place, through the winter. In the spring, such of the bees as have reached their term come out from their prison. These earliest insects are all males; but, though precocious in being hatched, they are still tender to the changes of the weather, and remain half frozen and torpid in the dust along with

the young of the *Sitaris*. The time has come for the last to begin to act. They have been called *Triongulins* by Léon Dufour, from the claws with which they are armed, and by which they attach themselves to the bodies of the *Anthophores* waiting for the next stage in the conditions that favor their development. With fine weather the female *Anthophores* come out and carry on their work of burrowing and storing up honey till the time of fecundation arrives. Then the *Triongulin* changes its quarters from the body of the male to that of the female, where it remains on the watch for the laying of the egg, when it transfers itself to that, and with it enters the honey-chamber. With it it is shut up when the *Anthophorus* closes the door of the chamber for another season. The *Triongulin* will not eat the honey, for it is sure death to it by drowning if it touches it. It floats on the egg and feeds upon it; when it has used up its ration, it changes its shape, as well as its habits and taste. It is as eager now for the honey as it was to keep away from it, and grows upon it till it goes through another change and becomes the *Sitaris* which we observe coming out from the chambers of the *Anthophorus*. Three years of assiduous studies and investigation were required to obtain this curious life-history. Contrast now the results obtained by Léon Dufour, an entomologist and naturalist of the school of Cuvier, with those which M. Fabre has reached by experiment.

I could also show you examples of an excessive socialism in societies of animals, even passing the limits of what has been conceived for men; comprising individuals whose parts are assigned with the greatest precision, some working to feed the collectivity, eating and digesting for all, others possessing the single function of reproduction of the species; and still others serving as beasts of burden for the rest; and looking a little further, we might occasionally discover idlers at rest while their fellows are working to feed them. Take the lobster which we fish from among the rocks and on the sea-coast. In the earlier part of its life, it swims at large on the surface of the fresh water. Its plump and fleshy body, so sought for as a food, is represented then by a broad and extremely thin plate, so peculiar that the zoölogists of the old schools made it not only a genus, but one of the types of a group very remote from its fellows. What would be the difference between these zoölogists and one who should regard the child and the adult of a savage man seen for the first time on some unknown island as forming two genera? Is it not evident that in the times of Linnæus and Cuvier, when they examined animals at only one moment of their existence, naturalists could not follow the filiation of facts which evolution alone reveals to us? The discovery of the *Triongulin* and the *Biorhiza*, made when species were defined only according to characteristics falling under the

senses, the surprising transformations of which had not been shown us by their evolution, could not possibly have informed us of the true significance of those beings.

I know very well that the quality of an experimental science which I claim for zoölogy is not accorded to us by all students. Those who withhold this recognition are specialists who judge of our science by what they learned of it when they were pursuing their general studies, and when it consisted chiefly of learning names and registering characteristics. They still think it a science of words and memorizing. But we are happily able to reflect that while they have followed and pushed on the science in which they have become masters, they have concerned themselves but little with the advance of the other branches which they have not cultivated; and their present judgment is based on the condition of the science a half-century ago. I think it can be established without contradiction that there is not a zoölogist of the present day, unless he be over-rash or ambitious to enjoy the discovery of a new species, who will venture to affirm that he is acquainted with any being before he has followed its evolution. To follow the evolution, experiments must be instituted, and that constitutes experimental zoölogy. Because our science is now in a critical condition, it is most positively affirmed by the partisans of the transformist theories that it should modify its methods of investigation, and besides registering species should submit unreservedly to experimental control. Such is the conclusion which we logically reach, and which imposes itself upon us to-day.—*Translated and abridged for the Popular Science Monthly from the Revue Scientifique.*

THE DECADENCE OF FARMING.

By JOEL BENTON.

SOME years ago the editor of a prominent journal sent me a slip containing a column and a half of advertisements of farms for sale, cut from a Boston daily paper. The farms offered were located in New England, where the supposed benign effect of the national Government's attempt to "diversify industry," so that farming need not be overdone, has had its supreme chance. These farms were not poor or worn out. They were in the midst of our best social culture, as developed by our most intelligent rural communities. Upon them were improvements and, in the main, good buildings. Railroads ran over or near every one of them; large factories and populous towns were near, to buy their products; schools and churches were visible, almost from their door-steps and gateways; beauty was in the landscape, and health

in the very air. Whatever the best civilization has to offer, outside of great cities or large towns, was accessible to the homes they represented. If anywhere on the planet human beings could be happy and prosperous, in beautiful homes, it should have been there.

But the farms were for sale, nevertheless; and, though this was fifteen years and more ago, some of them are for sale still. The column and a half of advertisements was only a sample of a hundred other columns of advertisements of a similar sort published in other New England papers; and the offers to sell still go on. The clipping sent to me, as symptomatic of a great movement, came from the office of a famous protectionist daily, and was sent in order that I might make some appropriate comment upon the situation, or give some advice which should be apt or remedial in relation to it.

This was done at a period, however, when there was no question of taxation or political economy uppermost in the public mind. No suspicion, even, was entertained that legislation of any sort was involved in the problem presented, or that any other than a hortative appeal to boys to stick to the farm, or some suggestion as to better modes of farming, was needed.

It is now twenty years, at least, that farming has been going rapidly downward. Farms bought in the war era have been selling almost everywhere in the East for from *one half* to *one third* of their cost. Farms in New England, and some in the Middle States, are frequently sold for less than the buildings cost which are upon them. This is really no exaggeration. Sales of this sort, and where the depreciation in value has wiped out the owner's equity in them, have been for years a matter of notorious knowledge in almost every Eastern community. Within a year, in a healthy and fertile county not sixty miles from New York city, a farm having on it two mortgages—a first mortgage of three thousand dollars and a second mortgage of two thousand—was sold, under foreclosure, for the sum represented by the first mortgage only. The holder of the second one did not think it worth while to be present, or to have a representative present, at the sale, to bid the single dollar which would have saved or made a show of saving his investment.

Very recently the New York State assessors have issued a report containing some results of what they have discovered so far as they have gone, in respect to the assessed valuations of farm lands in the various counties. And this is their story: "In fourteen counties visited they found that farming lands had depreciated in value, while city property had increased in value." State Assessor Wood is of the opinion that "in a few decades there will be few or none but tenant farmers in this State. Year

by year the value of farm lands depreciates." There is not the slightest reason to believe that there is a county in this State of which a better report can be made. The fourteen examined may well stand for all.

Following closely on this report for New York comes the report of the Bureau of Labor Statistics for Illinois, in reference to farm-mortgage indebtedness. This gives a summary of this indebtedness at the following periods, viz., in 1870, 1880, and 1887; and evidence is also given as to the actual value of farming lands in the State. By leaving out town and city lots, and the suburban district of Chicago, the purely agricultural part of this debt is seen. And it is given as follows:

Year.	Debt.
1870	$95,721,003
1880	103,525,237
1887	123,733,098

The report tells its own story; for farms are a constant quantity and do not increase. It is only the wave of debt that increases over them. As this report separates, with such accuracy as it can command, "mortgages representing deferred payments of purchase money from loans," the deduction of the commissioners is, that "the mortgage indebtedness of farmers for borrowed money has increased twenty-three per cent since 1880 in Illinois, and that this is more than *twice the increase* in the value of the farm lands. An increase in land values is reported in twenty-five counties, a decrease in twenty counties, while in sixteen counties the values have remained unchanged."

This is far from a pleasant showing for a State so naturally good as Illinois, and one which was so recently a new and almost a frontier Commonwealth. But you may go farther West and find figures of the same solemn sort. In the Western States the farm mortgages amount to *three billion four hundred and twenty-two million dollars*. This is equivalent to a debt of two hundred dollars *per capita* for each person, or one thousand dollars to each head of a family. The interest which these mortgages pay runs from seven to nine per cent, while the profit on the farm capital, to put it large, is only from four to five per cent.

But, take up any newspaper or magazine, and read its advertising columns in respect to loans. What are they which are most popular and extensively advertised? Why, they are "farm investment loans." "Sixteen years' experience without loss of a dollar." And the interest is delivered at your door almost. These siphons are now extending far beyond the Mississippi and Missouri, on the virgin soil of the continent. For a while they can be borne there, where the capitalization in a farm is either slight or nothing, and where the money borrowed is mainly for buildings

and improvements. But it can not be long, without a change of proprietors, the original ones dropping their title, and giving up the struggle to other lists of unfortunates.

There is no doubt but that the investments in these vampiric mortgages are good—that is, good for those who loan the money, and good also for those roving or stationary agents who make their commissions out of them, and who scour every Eastern town where money is to be had to put into this form of security. I am not blaming these negotiators. The money must be borrowed, and somebody must furnish it. But is it not pitiful that the one business in this world which seems nearest to man's primitive nature, without which no other could exist, and into which the moralist and the well-wisher of his species is ever ready to advise young men to go, should be the selected prey of the most destructive and cruel legislation that can be invented by the wit of man?

All over the statute-book, if there is a law made having any effect at all upon the farmer, it is with an almost malicious certainty—one might think, if he judged by its effects—made to operate against him. Is it a half-holiday, or several whole ones, that are enacted? The operation of them is not a help to, but is a draught against, the farmer. His cows and his crops, and Nature itself, to whose laws he is more than anybody else tied down, will not and can not accept their supposed advantage. His work must still go on; and these are only new stumbling-blocks in his way, which leave him shorn of his hired help, to pursue his tasks without the customary assistance. If an eight-hour law is enacted, its maleficence, not its advantage, falls on him. The milking-hour and the harvest will not be postponed in obedience to any legislature. So far as it makes the day's labor brief, so certainly it extends his own labor from twelve hours to fourteen.

Notice, too, how every tax system now uppermost puts the heavy end of its incidence on the farmer. In the State, county, and township allotment of fiscal burdens the tax is direct. It falls upon what can be seen and discovered with greatest weight. But it never fails to discover the farmer. His broad acres can not be hidden or sworn away; while his neighbor, rich in personal holdings, can cunningly suspend his own tax by evasion—and sometimes by an artful change or confusion of residence—so as to add his tax, too, to the tax of the beridden farmer.

But worse than all this is his relation to the national tax system, which exploits away his hard-earned profits, small in percentage, almost invisibly, and then adds abuse to injury by successfully persuading him that it exists for his supreme advantage. He pays for a paper, as likely as not, which tells him, and has been telling him for a generation or more, that the beneficent sys-

tem which prevents him from buying forty-five hundred articles as cheaply as he might, and compels him to sell his own products, minute in number, at the lowest price which ingenious legal artifice can dictate, is a measure for his particular benefit. If he has read a paper which denies this, the doctrine is so new to this generation that he has not yet mastered it; and he is apt to treat it with conservative inattention, or as a delusive suggestion, an investment in which must be set down for the present as one to be treated with as much caution as he would exercise in accepting an unheard-of and revolutionary scheme for working his farm.

The siren charm with which the word "protection" asphyxiates him has only casually, as yet, lost for him its sorcery. He is apt to have confidence in some regular order of things, such as the seasons, the sunrise, and the sunset; and to him "protection" is, and has been, through long experience, as stable a factor in affairs as the precession of the equinoxes or the laws of the solar system.

But, if he is ever to rescue his business and make it decently profitable, he must awaken from this long swoon. He must see and know that taxation of this sort is death to him; and is fast making it impossible for an intelligent American to live and raise a family with the decent comforts of life on the best farm in the New England and Middle States. Very rapidly, in New England, the farms are passing into the hands of the foreigner, or distinctly peasant element, a class which reduces the necessities of life to the simplest scale, and which is able to do farming within the family, and so can eliminate the costly feature of hired labor. The question has been asked for years, "How shall we keep our boys on the farm?" But it has never been answered successfully, and never can be. We ought to be profoundly thankful, considering what the farm now is as a business, that we can not keep them there. It is the best possible evidence attainable of the bright wit and level-headedness of the boys that they wish to work where gain is assured at the end of their toil.

I may be told, very likely, that I have skipped one feature of the tariff, the one on wool, which was devised especially for the farmer's profit. But it was not; and, if it had been, it has hurt him instead of helping him. It was devised by men who are either commercial men, or whose predominant interest is commercial rather than agricultural. These men constitute what is known as the Wool-Growers' Association. I think its important factor is made up of middle-men, or salesmen who traffic in the wool product. But, be that as it may, the duty on wool has simply handicapped the manufacturers of woolen fabrics; and by shutting out kinds of wool which we *can not raise here*, and which the woolen manufacturers *must* have to mix with native wools, has

actually lessened the demand for native wool, with the effect to *lower its price*. Apart from this, it is a notorious fact that the price of wool does not ever bear the relation it ought to, on protection theories, to the rate of the duty. I once traveled with a wool-buyer, years ago, when a lower tariff than the present one prevailed, when he bought wool of the farmers, to speculate on, and gave one dollar a pound for it, which was the market price. Does any wool-farmer expect to get over half that now? A very intelligent farmer, on whose hundreds of acres the wool product has been a feature for sixty or seventy years—a man who holds general "protective" opinions—told me frankly that the tariff, touching wool, gave no enhancement of price. He confessed that he had got very high prices for wool under a low tariff, and very low prices under a high one.

As this wool-bribe is a menace to direct and equal laws, and is the price offered the farmers for support of legislation absolutely hostile to them, suppose we look a little further on its effects. Here are some facts for farmers to think over. Twenty-one years ago there were thirty-eight million sheep in this country east of the Mississippi River. We have "protected" them all this time, and there ought fairly to be now, under a decent ratio of growth, at least fifty million. Are there this number? On the contrary, there are now only eighteen million one hundred thousand. And they and the wool itself have greatly declined in price. It is said that, since 1875, there has been an increase in the number of sheep of about thirty per cent. But this is accounted for by the extension of farms in our new Territories. The large flocks there are chiefly owned by aliens or absentees, and even these flocks, with their peculiar local advantages, are declining in value. Not a fraction of this increase in number can be due to the tariff, and no benefit comes from it to the growers of wool in the older States.

To supplement these facts properly, read the following answers to questions propounded by the "Massachusetts United Questions Club," given by ex-Congressman John E. Russell:

Question 4 is as follows: "Does the tax on foreign wool imported put the price of that up so much that, although the price of American wool is lower than it ever was before, yet our domestic woolen manufacturers are put at a great disadvantage with foreign manufacturers, so that we can not make goods at so low a cost or of so good a quality, except such kinds of goods as can be made wholly of domestic wool?" Mr. Russell replies that the specific duties on woolen cloths and flannels put the American manufacturer of fine goods at a sad disadvantage, confining him to the home market, and that the high price he is compelled to charge for goods narrows and restricts his market. Mr. Russell continues: "Makers of the fine flannels that are sold in competition with the best English and French goods import South American wool that has been sent to France and there cleansed of dirt and burs, and scoured. The duty on this wool is thirty cents a pound. There is no wool raised in this country that will answer the same pur-

pose. It is the result of a soil and climate different from ours. It goes to France because, though France is a protected country, they do not think it economy to tax the raw material of manufacturing, and they consider it wise to so draw the line of protection as to preserve commerce with nations producing raw material. They exchange goods for wool, they make the freights, commissions, and profits of shipping, and we pay them for manipulation of the wool."

"Question 5.—If the effect of the tax on foreign wool has been to put down the price of domestic wool and to put up the cost of woolen goods, who gets any benefit from it? Is it the farmer, who gets less for his wool and pays more for his clothing?"

"Answer.—The benefit of this tax accrues to the politicians and to other enormously protected interests. The tariff on wool is the key-stone of the wide arch of protection, because it binds the farmer to the support of the whole system. Without his support the tariff would be reduced to a tax that would raise only what is required by the Government economically administered, with incidental protection. How the farmer is deceived may be further explained by a calculation of what he gets even if he makes all that is promised him. The duty upon unwashed wool that comes in competition with ours is ten cents a pound, the average number of sheep in a flock upon the older Western farms is not over thirty, and the average product of wool on such a farm would be about one hundred and eighty pounds. If the duty increased the price of this wool ten cents a pound, it would be but eighteen dollars to each flock, or less than the enhanced cost of the clothes of his family. It gives him nothing to pay the increased cost of lumber, salt, tin, crockery, implements, fence-wire, etc. The fact is, that his protection fails to protect, and he gets nothing but the privilege of carrying the load. He is a victim of those who cut straps out of the hides of the poor to make stirrup-leathers for the rich."

The next question of importance is number 9. It is as follows: "Is not the farmer misled when, under pretense of protection to wool, the price of his wool is reduced and the export of his wheat and cotton is partly stopped, because by way of a tax on foreign wool we prevent in part an exchange of wheat, cotton, and flour for wool? Answer: 'Misled' is a weak term to use under the circumstances. We might say he is in the same position as the man who votes for high taxes to keep up his wages!"

If there is any farmer in the land who can read these undeniable facts, and, after doing so, is still willing the "wool" shall be "pulled over his eyes," he, at least, deserves little pity for his fate. Sheep ought really to be a profit to the farmer, as they are an important factor in soil enrichment. They ought not to be unprofitable if they grew hair in place of wool. But our law-makers have doomed them. The only "protection" they ever were in need of is protection from dogs and tariff-mongers.

There is really no probability that we can ever have a "farm-protecting" tariff, for obvious reasons. One is, the farmers are too numerous to organize efficiently. They lack the massed capital and commercial skill necessary to maintain a lobby at Washington. They are too vast and minutely divided a body to be thrown into any efficient cohesion. To move Congress and compel politicians, you want just the sort of conspiracy that exists and

is upheld by the tariff barons and beneficiaries—a comparatively few very wealthy corporations, each one "log-rolling" with the other for mutual benefits. By their employment of large bodies of workmen, and their power to contribute money and to bulldoze morally through the "pay-envelope," congressional districts, States, and the nation are in their clutch.

Of course, the farmer vote is great enough to have its way, but it can not apply itself with the force and ease of a well-regulated machine, as its almost feudal masters can theirs. Our farmers lack also, as I have already said, the clear perception that they and their interests are exploited. The system which robs them, under cover of law, large numbers of them still believe is for their own benefit.

It is a matter for amazement, though, that some leaders among them do not, at least, plead through their granges and societies, for *direct* protection, since they are so sure the complex taxation of themselves tends to their prosperity, by some indirect *hocus pocus* which nobody can explain. If protection is good for agriculture, it would certainly help it more to put it in the line of *direct* benefit, and let other industries, so long pampered, have for a change the *indirect* blessings of the tariff for a term of years.

As the farmers are by far the most numerous single part of our population, and represent well toward one *third* of the people in numbers, why not give to them *directly*, lavish bounties from the national treasury? Let an act, for instance, be passed to give them from fifty to one hundred and fifty per cent more for all they raise than they now receive. This would somewhere near double their income. With this great enlargement of their means they could pay more for labor, and they could buy two or three times as large a quantity of manufactured goods. Of course, "could" invariably means "would" in the protectionist's dictionary; and so we should see a tremendous impetus given to all other industries, and to manufactures particularly, by the very greatly increased purchases of the farmers and their doubly paid help. As it has been for two or more generations, "the few" have been protected on purpose to help "the many" by the tremendous overflow which the benevolence of "the few" precipitates. But just think how much more overflow would be sure to run from "the many" to "the few" than is possible in the other direction!

Could there be any finer or fairer scheme than this? Having lived in the moonlight of protection so long, is it not the farmer's turn now to have its sunlight? And, inasmuch as the manufacturers and protected interests say that this moonlight, or indirect incidence of their tax system, is a great good to the farmer, it will, of course, be of great good to the manufacturer. And there will be vastly more of it, since large bodies reflect immensely more to

small ones than small ones do to large ones. Or are the protected interests really afraid to take their own prescription? We suspect they would be, and, in fact, could not be hired to take it.

But it is the impending truth—which will some day, and I think very soon, filter into the farmer's mind—that alone can save him. When he sees that he, and he most of all, is bled for others, and for their private gain, he will cease to believe in enforced phlebotomy. When he finds out that the word "protective," so far as he is concerned, is an abominable misnomer, and should be translated "destructive," there will be heard a voice from the farms that will give the system so long delusively described its death-blow. Years ago the farmer's boy, when he went to school, was taught that the business of the United States consisted of "agriculture, manufactures, and commerce." It has long since ceased to be an equal tri-division. Agriculture and commerce, as they once were, are things of the past. The one has been made unprofitable beyond description; the other is now impossible, except in a reduced way, under an alien flag. Ship-building is "protected" to death, and the American money that goes toward having it done abroad simply builds ships that, in case of a war, can be turned against our own shores and our depleted navy. But we have—as trophies of our absurd Chinese system—manufactures (none too flourishing, if the men engaged in them know) and a "protective" tariff.

The long endurance of the superstition on which "protection" is based has had two bulwarks—the necessity for revenues extraordinary, and the power of money, contributed by directly interested parties. An economically administered government should break down the first, and the force of facts the second.

As we hold in derision now the discovery of the philosopher's stone and perpetual motion, so future generations will look upon this fetich of our time, and not without unspeakable amazement. They will see a generation here and now that is trying to lift itself over the fence by standing in a corn-basket and pulling upward on the handles. The wonder will not be so much that they tried, as it will be that for so long a time they supposed they were successfully performing this impossible feat.

THE history of the genus *Platanus*, which includes the Oriental plane-tree and our sycamore, has been traced by Lester F. Ward back to the Tertiary period, when there were at least twenty species, mostly American or arctic. The genus and the entire type to which it belongs seem therefore to have been American; and its numerous and strange archaic forms "not only formed the umbrageous forests on the shores of the great inland Laramie Sea where the Rocky Mountains now stand, but also those of the ocean at a time when it still pushed its arms northward across what are now the great plains of Texas, Colorado, and Wyoming."

SENSITIVE FLAMES AND SOUND-SHADOWS.

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THE conception that sound is due to wave-motion in an elastic material medium was first distinctly expressed in the sixteenth century by Lord Bacon. He distinguished between local motion in a medium and the propagation of this motion through it, referring to the transmission of sound through both air and water by way of illustration. For measuring the velocity of sound in air he proposed a plan which has been repeatedly applied since his time, that of firing a cannon and noting the interval between the flash and the report as heard at a measured distance.

It is impossible now to determine how far these observations may have been original with Bacon, or to what extent they may have expressed the current knowledge of his time. They were clearly apprehended by Galileo, who discovered the law of simple harmonic motion and made the first well-authenticated experiments on the relation between vibration frequency and musical pitch. But it is to Sir Isaac Newton that we must give the credit of first applying the wave theory rigorously to the phenomena of sound. Assuming this theory, he showed the possibility of calculating what ought to be the velocity of propagation through any medium of known elasticity. He deduced a formula which has been found applicable to most media. In the case of atmospheric air it failed, but because it required a correction dependent on certain laws of heat which had not then become known. The correction was made by Laplace, and the formula, as thus completed, is now found to be applicable to all known gases. This was only one of the many important principles established on a mathematical basis in the "Principia," and published in 1687.

Even before this date, the conception that light, as well as sound, might be due to wave-motion seems to have been grasped by a few thinkers. In 1665 a book on "Light and Color" was published at Bologna, two years after the death of its author, Francesca Maria Grimaldi, a Jesuit priest and astronomer. In this he recounts some interesting experiments, which did not, it is true, lead him to the wave theory of light, but served as the basis on which this theory was subsequently established. Similar experiments were made soon afterward by Robert Hooke, the ever-jealous rival of Newton, and by Christian Huygens, their distinguished Dutch contemporary. Huygens demonstrated that, if an impulse be given to any single particle in a uniformly elastic material medium, it must be propagated thence as wave-motion

equally in all directions; and that the propagation of a wave front in any given direction is the result of a multitude of interferences among the elementary waves started from the particles which are successively disturbed. Accepting this principle, the laws of reflection and refraction, whether of light or sound, follow immediately; and they were worked out with great skill by Huygens. Another consequence is, that if an obstacle be interposed in the path of a wave, its edges must serve as new centers around which secondary waves will be propagated, while the main wave continues to advance. This is familiar in the case of water-waves.

If, therefore, light be due to wave-motion, no perfect geometric shadow is possible, for the shadow must suffer encroachment from these secondary waves thus diffracted. Such phenomena were actually observed in the case of light by Grimaldi, Hooke, and Huygens, but no satisfactory explanation was then given. It is surprising that Huygens did not think of applying the theory which had been so satisfactory in its application to other optical phenomena. He had not attempted to measure the length of waves of light, and had no conception of their exceeding minuteness. If any diffraction phenomena were to be observed, the encroachment for which he naturally looked was far greater than what had been noticed as inexplicable and almost imperceptibly narrow fringes. The absence of the diffraction phenomena such as he may have expected did not cause him to abandon his wave theory, though he could not but perceive that it constituted a stumbling-block. To the mind of Newton this obstacle was insuperable; it determined his rejection of Huygens's theory.

If Newton was not the inventor of the emission theory of light, he was certainly its most ardent advocate. It came into prominence along with the wave theory, or indeed a little after this; and by means of it very satisfactory explanations could be given of most optical phenomena. Newton's reasoning, and the authority of his great name, caused its acceptance by all contemporary physicists, except Hooke, Huygens, and Euler, and by all his successors for a century. Whichever of the two theories is accepted, assumptions are involved which are open to attack and incapable of being substantiated on any antecedent grounds. Its value has to be measured alone by its consistency with observed facts. It was not until about the beginning of the present century that Dr. Thomas Young revived the long-discarded wave theory, explained the diffraction of light by its aid, and showed the incompetency of the emission theory. His views were at first generally rejected, but in time they attracted the attention of Arago and Fresnel. The latter especially entered into the investigation with enthusiasm, and completed the establishment of the wave theory upon foundations that have never since been successfully assailed. The elastic

medium required for the propagation of light-waves, whether through interplanetary space or terrestrial bodies, is the universal ether, of whose existence we have no evidence except that, by assuming it and applying mathematics, the results of computation are exactly corroborated by observation and experiment. The elastic medium required for sound-waves may be solid, liquid, or gaseous. In any case it must be material.

Assuming, then, an obstacle in the path of a wave of sound or light, a shadow should be produced; but since the edges are sources of secondary waves, according to Huygens's principle, these should encroach upon the shadow. The degree of encroachment can be expressed in a mathematical formula, and is thus shown to be proportional to the wave-length. The average length of a wave of green light is now known to be about $\frac{1}{50000}$ of an inch. The encroachment on the geometric shadow is hence so small that refined methods are needed to make it perceptible. In the case of audible sound, on the contrary, when propagated through air, the wave-length is ordinarily so great that the encroachment almost wholly masks the presence of any shadow whatever. For the pitch C, 132 vibrations per second, such as is often used by men in conversation, the wave-length is readily calculated, if we know the velocity of sound in air. Taking this as 1,120 feet per second, there will be 132 waves strung out over this distance in each second. The length of each is hence eight feet and six inches, or more than five million times as great as that of the average wave of light. For such waves it is hopeless to attempt producing any well-defined shadows.

One of the most familiar facts in physics is that the pitch of a note becomes higher, and hence its wave shorter, in proportion to the increase of vibration frequency. If well-defined sound-shadows are possible, we must resort to sounds of very short wave-length. If the sound is continuous instead of explosive, this shortness implies very high pitch. There are mechanical difficulties to contend with which make it hard to give much intensity to very acute sounds. The range of audition, moreover, is limited. For persons of good ear the range may be roughly stated as from 25 to 25,000 vibrations per second for sounds of small intensity; indeed, many fail to perceive any pitch exceeding 15,000. To exhibit sound-shadows, therefore, it becomes necessary either to employ a source that sends forth sounds of such high pitch as to be inaudible to most of those who are expected to perceive the shadow, or to resort to a momentary sound of great intensity and short wave-length.

Every one has noticed the decrease in intensity of the sound of a distant railway-train as it passes into a cutting. The observer is in a shadow which is incomplete but nevertheless noticeable.

The secondary waves, which are started at the upper edges of the cutting, reach the ear and give still a good idea of the character of the noise and position of the train. The range of the ear greatly exceeds that of the eye, not only in relation to the variety of wave-lengths by which it may be impressed, but yet more as to variations of intensity. Just as sunshine and shadow during the day indicate merely variations in illumination without the complete extinction of light, so noise and sound-shadow are merely relative terms, the latter not necessarily implying the complete extinction of sound; for in air diffraction usually plays so important a part as to forbid complete extinction, and to prevent all sharpness of definition at the edges of the shadow.

When the medium is water instead of air, some new phenomena are noticeable. In 1826 Daniel Colladon's classic experiments on the velocity of sound in water were performed on the Lake of Geneva. The source of sound was a large bell, from which vibrations were conducted through the water several miles away to an elastic membrane stretched across the expanded opening of a partially submerged hearing-trumpet. They were thus given to the air within the trumpet and conveyed to an ear applied at its smaller end above the water. A bell when struck sends forth a variety of tones, and it is often hard to determine which of these is most prominent. Usually that of deepest pitch is the slowest to die away in air, and often it penetrates to the greatest distance. Colladon made the remarkable observation that in water the lower tones are conducted off to but a short distance before their energy ceases to produce the sensation of sound; while the initial stroke is propagated much further, and is then perceived as a short, sharp, almost clicking sound, without definite musical character. Placing the hearing-trumpet behind a wall which projected out into the water, the decrease of intensity was much greater than under similar conditions in air, and the demarkation of the region of shadow was decidedly more noticeable.

Still more interesting than the experiments of Colladon were those made in the Bay of San Francisco in 1874 by Prof. John Le Conte and his son, Mr. Julian Le Conte. The source of sound was not such as would give a definite pitch, like a bell, but the quick, violent, single impulse due to the explosion of dynamite employed in the blasting of rocks which obstructed the channels. The intensity of the shock thus propagated was such as to be felt as a blow on the feet of a person seated in a boat three hundred feet or more from the detonating cartridge, and to kill hundreds of fish. Several vertical posts or piles, each about a foot in diameter, projected from the ground out of the water in the neighborhood. A stout glass bottle was suspended in the water about a foot in the rear of one of these piles (Fig. 1), within the geomet-

ric shadow determined by lines supposed to be drawn from the cartridge forty feet horizontally away. The bottle was perfectly protected from the shock of the explosion. It was then put in front of the pile. The first shock shivered it into hundreds of fragments. Other bottles, some filled with air and some with

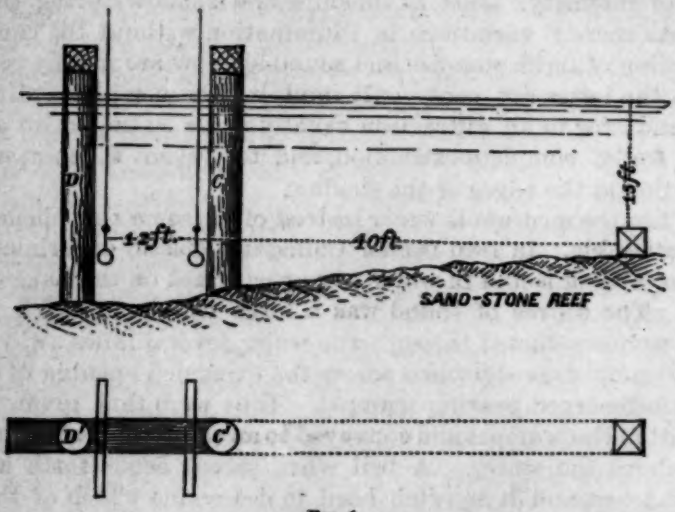


FIG. 1.

water, were similarly exposed in various directions around the pile, and with the same result—destruction, except when within the protecting shadow. The experiments were varied by immersing stout glass tubes (Fig. 1), incased in thick paper, horizontally across the direction of the sound-rays in water, between two piles which were aligned with the dynamite cartridge. These piles were twelve feet apart, the nearer one being forty feet from the cartridge. Its shadow, therefore, just covered the second pile, and included the intermediate water, with the middle part of each tube. After an explosion these protected parts were found to be unbroken, while the ends which projected on the two sides beyond the shadow were completely shattered (Fig. 2). The boundary between the regions of shadow and noise was sharply defined on the tubes, even at a distance of twelve feet behind the protecting pile.

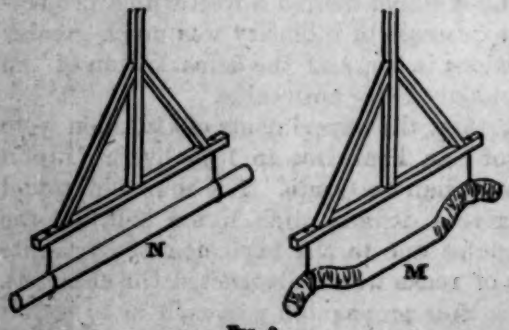


FIG. 2.

To account for the shortness of the sound-waves which were

capable of producing such sharp shadows, Dr. Le Conte advances what seems to be the only tenable theory, and one which equally explains the observations of Colladon on the clicking sound of a distant bell as heard in water. In the absence of any recognizable pitch—for pitch implies a series of impulses recurring in regular order—there is no means of determining wave-length in these cases. But whatever this may be, the wave-length is equal to the product of the time consumed in generating the wave and the velocity of propagation. Thus, assume the initial pitch of a bell to be 220 vibrations per second. We may compute the wave-length either by considering that 220 waves are strung out over a distance of 1,120 feet, making each a trifle more than five feet long, or we may say that the time consumed in generating each wave is $\frac{1}{220}$ of a second, and that this impulse is propagated at the rate of 1,120 feet per second, which would be a little over five feet in $\frac{1}{220}$ of a second. The blow of the hammer on Colladon's bell was almost instantaneous, and the intensity of the first shock thus given to the water was far greater than that of any subsequent shock due to the succession of vibrations set up in the elastic bell-metal. The distance through which this intense sound would be propagated might be expected greatly to exceed that traversed by the subsequent weaker vibrations. The generating blow was so brief that the wave-length could only be short; and hence comparatively well-defined sound-shadows were produced at a distance. In the case of the dynamite explosions under water this reasoning holds with yet greater force. If the duration of the generating impulse be only a millionth of a second, and the velocity of propagation in water be 4,700 feet per second, the resulting wave-length would be only about $\frac{1}{17}$ of an inch. The quickness of action manifested in the explosion of dynamite exceeds that of any other known agent that has ever been similarly employed. The duration of the generating impulse may be considered indefinitely small, certainly immeasurably small. The sharpness of the sound-shadows it produces in water indicates a wave-length that can not exceed a small fraction of an inch.

The production of sharp sound-shadows in air is of more recent date than the experiments in water. In 1880 a dynamite-factory near San Francisco was destroyed by the explosion of its contents. On a large building three miles away many panes of window glass on the side toward the explosion were broken, and two shocks were felt, one conducted by the air and the other by the ground. In the acoustic shadow cast by this building, nearly nine hundred feet away on the side remote from the explosion, no aërial shock was experienced, though that from the ground was distinctly felt. The shortness of the air-wave due to exploding dynamite sufficiently accounts for the sharpness of the shadow.

But there is now no longer any necessity to resort to such dangerous sources of sound as dynamite. Whistles may be made which yield tones exceeding twenty thousand vibrations per second. The wave-length corresponding to such a pitch is less than an inch. The advantage presented is that the sound is continuous, and it may be made as constant as we please by supplying the whistle from a cylinder full of compressed air, regulating the pressure by means of an appropriate gauge. The disadvantage is that the intensity is but slight, and the pitch is too high to be perceived as sound by most persons unless the ear is closely applied. An artificial indicator must hence be used, whose motion under the disturbances due to sound can be seen at a distance.

In 1857 Prof. John Le Conte discovered that an ordinary naked gas-flame, from a fish-tail or bat-wing burner, becomes an indicator of sound by vibrating in unison with an external source, provided the pressure be such that the flame is just ready to flare. This can be easily shown by blowing a shrill whistle or bowing a tuning-fork of high pitch in the immediate neighborhood of the flame, which at once becomes forked (Fig. 3) into several long, vibrating tongues. The effect soon ceases if the pressure be gradually diminished. This result is due to the disturbance produced by sound-waves on the outflowing jet of gas at the nozzle. The high temperature of flame is therefore not necessary for the production of such co-vibration, but serves to make it more easily manifest.

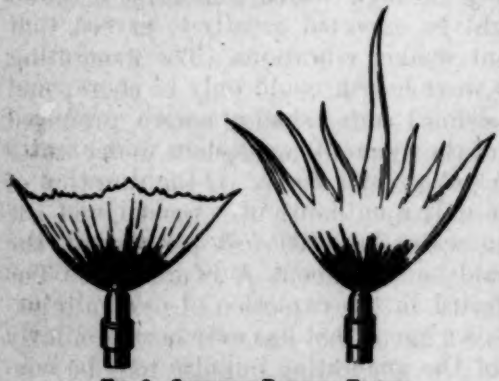


FIG. 3.—SENSITIVE BATWING FLAMES.

Nine years elapsed after Dr. Le Conte's discovery before the subject was taken up again and independently by Mr. W. F. Barrett, in London, who used small cylindrical jets, which were found to flare under similar conditions, and could be rendered far more sensitive. A "pin-hole lava-tip" may be fitted into the end of a metal tube and connected by means of India-rubber tubing to a cylinder of compressed illuminating gas. In connection with this, also, there should be a water manometer gauge for regulating the pressure of the outflowing gas. If the pin-hole is very smoothly cylindrical, the flame mounts up to the height of nearly eighteen inches (Fig. 4, *x*), with an apparent thickness scarcely more than that of the little finger, and burning quietly. When the pressure approaches ten inches, as indi-

cated by the water-gauge, the flame flares, becoming much shorter and broader, like a little Indian club (Fig. 4, *y*), and producing a low roaring sound, due to the escape of unburned gas. Let the pressure now be diminished until this flaring barely ceases. The flame is now in its most sensitive condition. Sounds of low or even medium pitch have no effect upon it; but on blowing a shrill whistle, or rattling a bunch of keys anywhere within thirty or forty feet, it flares. Perhaps the most beautiful illustration of its sensitiveness is given by placing an open watch near the nozzle but not touching it; every tick causes a momentary sinking and spreading of the flame, so that the effect may be seen across an audience-room. If the audience applauds with clapping of hands, the flame shrinks in acknowledgment.

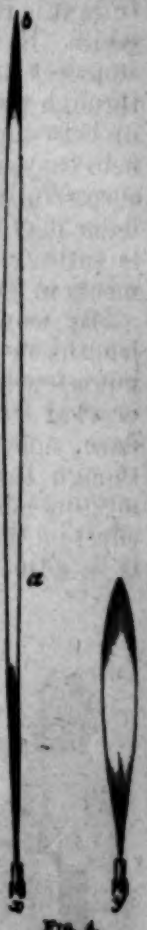


FIG. 4.

A very sensitive flame, but not so convenient as that of Prof. Barrett, and not visible at so great a distance, may be obtained with no pressure greater than that of the street mains, by causing the gas to issue from a small tube, over the orifice of which, at a height of an inch or two, is placed a piece of wire gauze (Fig. 5). The mixture of coal-gas and air is ignited above the gauze, and a glass tube may be used to protect the flame from currents of air, though this is not usually necessary. Very little adjustment is needed to find the distance between nozzle and gauze at which the flame is most sensitive. This arrangement was devised independently by Prof. Govi, of Turin, and Mr. Barry, of Ireland. The flame is deficient in brightness, and is only a few inches high at its best, but has the advantage of not requiring any appliances that may not be easily supplied in any town. If Barrett's flame is available, however, it is decidedly preferable to anything else.

With such a flame as Barrett's it becomes possible to explore the air and detect regions of relative noise and silence just as a delicate thermometer enables us to determine variations of temperature in different layers of air or water. If the pitch be too high for the ear to estimate or even detect it, the sensitive flame is more delicate than the ear. Armed with a whistle yielding a pitch of twelve or fifteen thousand vibrations per second, and with a good flame, many beautiful analogies between sound and light may be exhibited with entire satisfaction to an audience of deaf-mutes, if the lecturer's fingers are fairly nimble, since there is no necessity for the sounds to be heard. Most of the experiments about to be described were devised by Lord Rayleigh, the suc-

cessor of Prof. Tyndall in the chair of Natural Philosophy at the Royal Institution in London.

Let the whistle be supplied with a continuous blast of air, or any compressed gas, at steady pressure. Four or five feet away from it is placed the nozzle of the burner from which the flame issues. Its sensitiveness may be regulated at will by means of the stop-cock and the water manometer gauge. Turning on the blast through the whistle, the flame flares. Let the open hand be held up between the two; the flaring ceases. The nozzle of the burner is in the acoustic shadow cast by the hand. If this result is not successfully attained at the first trial, the sensitiveness of the flame may be slightly modified to suit the conditions. The case is entirely analogous to that of the glass bottles in the experiments in San Francisco Bay.

By using a small mirror to reflect the sound-waves, their lengths may easily be measured in mid-air. Let the mirror be put a few inches behind the flame and moved slowly toward this or away from it. At certain distances the flame is observed to flare violently, and at certain other points it becomes quiet, though the sound has not been varied. Reflected waves are meeting advancing waves. Where they meet in like phases, their effect on the flame is intensified. But if the position of the mirror is so adjusted that the flame is at a point where the opposing waves meet in unlike phase, these neutralize each other and the flame ceases to be agitated. The case is like that of producing loops and nodes on a string attached at one end to a vibrating body and fixed at the other end. A series of sinusoidal curves travel over its length, and are reflected from the fixed end, producing the so-called stationary waves (Fig. 6). A returning sinusoid is superimposed on an advancing sinusoid, producing two loops, with an intermediate nodal point of rest and a node at the end. The whole sinusoid represents a wave-length, and the distance from node to node a half wave-length. The distance through which the mirror is moved from one point of flame quiescence to the next is a half wave-length for the pitch yielded by the whistle. In some experiments thus conducted by the writer, this distance was found to be a trifle over half an inch. The whole wave-length was 1·05 inch. Assuming the velocity of

FIG. 5.

sound to be 1,120 feet, reducing this to inches, and dividing by 1·05 inch, the pitch of the whistle was thus found to be in the neighborhood of thirteen thousand complete vibrations per second. In no other way could this pitch be determined, for the most accomplished musician loses his power of discriminating pitch when either the upper or the lower limit of audition is approached. The pitch of the highest tone employed in music does not exceed five thousand vibrations per second.

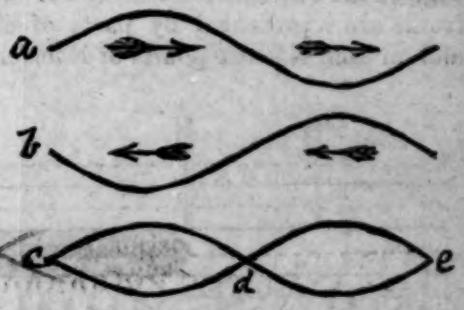


FIG. 6.—*a*, advancing sinusoid; *b*, returning sinusoid; *c*, advancing and returning sinusoids, forming two loops and a node; *c e* is a whole wave-length; *c d*, a half wave-length.

In performing this experiment Lord Rayleigh discovered an interesting peculiarity of the human ear in contrast with the sensitive flame. By using a tube, whose opening was placed alternately in the aërial loops and nodes, and conveying the sound thus to the ear at the same time that the flame was alternately agitated and quiescent, he found that the ear was most affected where the flame was least affected, and *vice versa*.

The flame, moreover, is unequally sensitive in two directions at right angles with each other. In drilling the small cylindrical hole of the burner no amount of care is sufficient to prevent minute irregularities. The current of issuing gas is not absolutely cylindrical. It is disturbed slightly by interior currents from side to side, and these affect the sensitiveness of the jet to external disturbances. To test this, let the nozzle be rotated on its own axis while the whistle is sounding, until the maximum effect is noticed; and let the sensitiveness of the flame be slightly reduced without causing it to cease to flare. On rotating the nozzle now through a right angle the flame is found to become quiet. Let a mirror be put on one side of the flame, a short distance off, so as to face the sensitive side. Adjusting it until it is equally inclined to the directions of flame and whistle, the flaring is started anew. This ceases when the mirror is rotated toward either side through a very small angle. Indeed, no more beautiful and exact illustration could be devised for showing the law of reflection of sound-waves. The sound-ray, taking a longer and broken path, disturbs the flame on its sensitive side, while the direct rays are at the same time beating in vain against what by analogy we may call its deaf side.

Probably the most interesting acoustic phenomena to be investigated by the aid of the sensitive flame are those of diffrac-

tion, or the measurable encroachment upon sound-shadows. In the accompanying diagram (Fig. 7) suppose the arrows to represent the direction of a group of parallel rays of either sound or light, the wave fronts being indicated by lines across the direction of the arrows. Waves in one phase are indicated by the continuous lines, and those in opposite phase by the dotted lines. At each edge of the obstacle are the centers of the secondary waves, whose fronts are represented by parts of circles. Behind the obstacle and on each side are points of interference represented by crosses

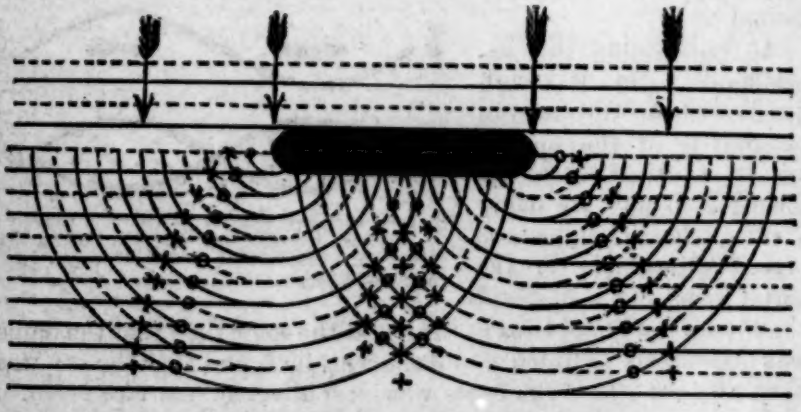


FIG. 7.—EXTERIOR AND INTERIOR DIFFRACTION.

and zeros. Behind it the secondary waves from opposite edges meet each other. At the sides, secondary waves interfere with the advancing main wave. Where like phases meet, the crosses represent points of increased disturbance. Where opposite phases meet, the zeros represent points of quiescence. If the waves are those of light, the crosses are points of increased brightness; the zeros, of comparative darkness. If the waves are those of sound, the crosses are points of noise; the zeros, of silence. Behind the obstacle there is a middle line of crosses; on each side of this a line of zeros; and outside of these are lines of crosses again. These lines are parts of hyperbolas, whose foci are the centers from which the secondary waves are started. This is readily seen by reference to the next illustration (Fig. 8). A necessary consequence is, that if light radiating from a point or a small aperture be interrupted by interposing a small disk in its path, there should be a line along the middle of the shadow behind it, at certain points of which brightness appears if a translucent screen is placed across the shadow. This fact was noticed by a Frenchman, Delisle, before the birth of either Newton or Huygens, but was of course not understood and was soon forgotten. Dr. Young seems not to have thought of it, or certainly never put this consequence

of theory to any test. The first physicist to recognize the value of Young's optical papers was Arago, who at once adopted the wave theory and started his friend Fresnel on a series of optical researches that are now classic. In 1819 Fresnel gained a prize from the French Academy for his work on diffraction of light. Before the report was made to the Academy it was examined by the mathematician Poisson, who criticised it by showing that, if the wave theory were accepted, the shadow of a small disk should have a bright spot in the middle, due to diffraction, the illumination of which should be the same as if no disk had been interposed. Arago at once tried the experiment; and what Poisson had urged to prove the impossibility of Fresnel's views was found to be a startling proof of their correctness. The experiment is easily tested, requiring no more expensive apparatus than a mirror outside of an opening in a window, a small bullet suspended by a thin wire, and a piece of roughened glass to receive the shadow. A pin-hole through a sheet of tin foil covering the window opening yields the required light from the mirror. The acoustic analogue of this celebrated experiment was first accomplished a few years ago by Lord Rayleigh; it has been lately often repeated by the writer and perhaps others. A disk of cardboard about a foot in diameter is put between a whistle and sensitive flame, with careful adjustment of distance and sensitiveness. In certain positions the flame is protected within the shadow of the disk; but, by moving the latter to and fro, one position is found where it causes the flame to be violently agitated by the meeting of waves diffracted at the edge of the circle. The diffractive effect is the same as if the impervious disk were a lens converging the sound-waves to a focus.

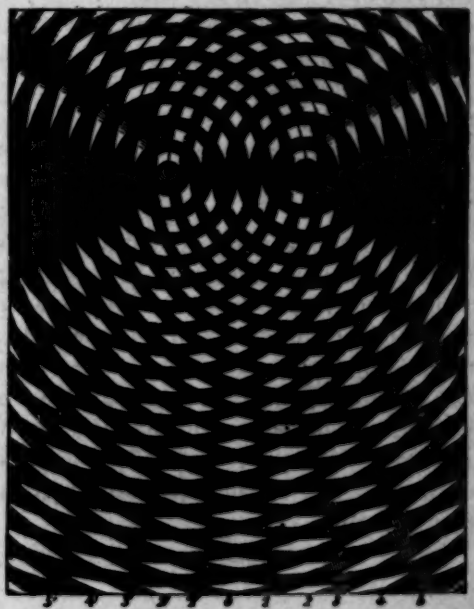


FIG. 8.—HYPERBOLAS PRODUCED BY INTERFERENCE OF WAVES.

The effect just described may be much intensified by constructing an acoustic diffraction grating and using it in place of the simple disk. The explanation of the principle on which such a

grating is made is beyond the scope of the present paper.* Assuming its use, the sensitive flame enables us to detect a focal area of noise, at which the flame is violently agitated, and around this are alternate rings of silence and fainter noise diminishing in strength with increase of distance from the central focus.

By admitting light through two small openings close together, the waves coming from a distant bright point and hence reaching the two openings in the same phase, hyperbolic lines of interference like those shown in Fig. 8 were traced in space by Fresnel. The writer has recently done the same with sound-waves, using the sensitive flame as an explorer. Bands of alternate noise and silence have in like manner been traced by him in air, produced by interference between the waves proceeding directly from the whistle and those reflected from a smooth surface placed horizontally on the table.

The wave theory of sound has long been impregnable; but these beautiful analogies between light and sound, though provided for by theory, have been experimentally demonstrated only recently. Such new and unexpected confirmations, new points of contact, are always welcome, even though they be not needed for the establishment of a theory. They are the results of prevision based on the assumption that an elastic material medium is needed for the propagation of sound, and are wholly inexplicable on any theory of emanation analogous to Newton's emission theory of light.

CONDITIONS AFFECTING THE REPRODUCTIVE POWER IN ANIMALS.

By JAMES H. STOLLER,

ADJUNCT PROFESSOR OF NATURAL HISTORY IN UNION COLLEGE.

MODERN biology has made familiar the idea that animals are not fixed and unalterable in their bodily structure and functions, but, within a certain range, respond by changes in themselves to changes in their physical surroundings. This has always been observed to be true for the individual animal, as in the changes undergone in adaptation to the seasons of the year; mammals, for instance, acquiring a thicker coat of hair at the approach of winter, and reptiles and other classes passing into a low state of functional activity called hibernation or winter sleep. But it has now been well shown that this principle of modification by environment applies to species as well as to individuals. That

* For this explanation the reader is referred to an article on "Diffraction of Sound," in the "Journal of the Franklin Institute," for June, 1889.

is to say, in long periods of time species of animals are affected by changes in external conditions according to the same principle of natural law by which individual animals are affected in short periods. It is to be understood, of course, that species are affected by other causes than a changed environment—causes such as are included in Darwin's phrase of natural selection—but the fact of the modification of species becomes evident when it is seen that familiar observations made upon individual animals have an application to species also.

It is clear that the modifications thus undergone are primarily functional rather than structural, since no part of the animal body can be altered in its anatomical characters except through physiological action. But it is also true that functional modifications occur not merely as subordinate to structural changes but as ends in themselves. That is to say, functional activity may be increased or diminished in response to changes in external conditions without any necessary sequence in changes in the structure of the organs exercising the function. An illustration of this is found in the well-known fact that warm-blooded animals (excepting those that hibernate) need more food in winter than in summer to keep up their normal temperature, occasioning a considerably increased activity of the nutritive functions, but without any attendant structural changes whatever in the organs of alimentation. The same holds true with hibernating animals, which, on the other hand, take no food for a long period, the nutritive function being greatly reduced in activity, yet the organs exercising this function undergoing no structural changes. In respect to species of animals, we should not expect to find the principle hold true so strictly as in individual animals, since increased or diminished functional activity extending through many successive generations could scarcely fail to have some effect on organic structure. But the point to which special attention is here directed is that *function as well as structure* responds to changes of environment, and that variations in functional activity occur without any closely correlated changes in structure.

The present object is to show that the reproductive function in animals is profoundly affected by conditions of environment. It will be sufficient to state the law or principle according to which the activity of the reproductive power appears to be regulated, and then to adduce instances exemplifying the law.

When circumstances are such that most of the ova produced are likely to develop, and the young to reach maturity, then the reproductive function is least active; on the other hand, when by reason of lack of food-supply or danger of destruction by adverse physical conditions, or by natural enemies, it is probable that only a small proportion of the ova will give rise to mature animals,

then the reproductive function is most active. The law may, therefore, be stated thus: The activity of the reproductive function is in proportion to the unfavorableness of the embryonic environment. The following instances are adduced:

TAPE-WORM.—The common tape-worm, *Tænia solium*, parasitic in the human intestine, consists in structure of a series of flat, oblong segments, sometimes eight hundred in number. Each of these segments is sexually perfect, containing both the male and female reproductive organs. The number of ova capable of development in each sexually mature segment is probably not less than five thousand. At this time the segment detaches itself from the others and is discharged from the body. In order that the ova shall develop, it is then necessary that they should gain access to the alimentary canal of the hog. If by chance they are swallowed by this animal, they quickly pass into the larval or cystic stage, burying themselves in the flesh or liver of their host, whence they may be transferred to the alimentary canal of man, where development is completed.

Now, it is obvious that this complex and fortuitous round of life renders the chances of the development of any single ovum exceedingly small. It is not probable, indeed, that one in ten thousand of the ova discharged from the alimentary canal of the host of the mature worm will ever reach the alimentary canal of the host of the larval worm. The embryonic environment is, therefore, in this case, exceedingly unfavorable by reason of its extreme narrowness. There is but one situation in which the development of the ovum can occur, and it is altogether accidental whether it reaches this situation. The explanation of the enormous capacity of the reproductive power in this animal is thus at once apparent. To compensate for the exceedingly narrow chances that the reproductive cell shall survive to complete issue, these cells are generated in excessive numbers.

APHIDES.—The aphides are commonly called plant-lice, and are very abundant in summer upon the leaves of most plants. They mature quickly, at least eight or nine generations following one another in a single summer. So prolific are they that it is entirely within bounds to say that a single insect may give rise to several millions of progeny, counting the successive generations, within a few months. This astonishing fertility is dependent upon a peculiar modification of the reproductive process in these insects. During the summer there are strictly no males nor females, but all are sexually alike, and are able to produce ova which develop *without fecundation*, this exceptional method of reproduction being termed *parthenogenesis*. Here, then, we have a remarkable variation of the reproductive function resulting in an enormous increase of prolificness. And here again we find an

explanation of this variation in the conditions under which the young develop. These insects are a common prey for other animals, especially birds, which devour them in great numbers, their exposed condition upon the surface of leaves rendering them easily obtainable. Hence it is that of the total number of ova produced only a very small proportion result in an increase of their kind, the young insect being devoured before completing maturation. This extraordinary and anomalous increase of the reproductive power thus furnishes an extreme instance of the operation of the law under consideration.

THE OYSTER.—It is well known that the oyster is very prolific. A single individual may produce over a million young. It is generally known, too, that this animal has many natural enemies, the most destructive being the star-fish. It is obvious that the reproductive power is here in relation to the unfavorableness of the natural environment, and especially during the embryonic period, when the body is small and less adequately protected, being destitute of a shell in the earliest stages.

THE CODFISH.—While most fishes produce eggs in great numbers, the cod is especially remarkable in this respect, a single female depositing annually eight or nine millions. The liability of destruction of the ova and young is perhaps at its maximum here, there being many natural enemies and very slight means of defense. The application of the law is obvious.

It seems unnecessary to bring forward other instances to show that the law holds good when the conditions of embryonic life are unfavorable. While it can not be so strikingly shown when the opposite conditions prevail—when the circumstances of embryonic life are favorable—it scarcely seems doubtful that it is less applicable here. When animals have abundant food-supply and ample protection against their foes and against exposure to weather, etc., the reproductive function is generally only moderately active. Without citing particular instances, it may be sufficient to point out that the largest and most intelligent animals—those that are strongest in body and quickest in instincts, and thus best able to defend themselves and their young against their enemies and to secure food and shelter—are the least prolific, bringing forth young at longer intervals and in fewer numbers.

It may have occurred to the reader that while there thus seems to be a law governing the procreative power in animals, this law is yet subordinate to another more general, more fundamental law—the law of the preservation of the species. Nature guards against the destruction of her works, and the instances of excessive activity of the reproductive function we have noted are to be interpreted as efforts made in the economy of nature to save the species from extinction.

ISRAELITE AND INDIAN: A PARALLEL IN PLANES OF CULTURE.*

By GARRICK MALLERY.

I.

AXIOMS and postulates long limited man's study of man. This hampering has been peculiarly marked in reference to America, the assumption being that it must have been peopled from the eastern hemisphere, and that its languages, religions, and customs must have been inherited from nations registered in Eurasian records. Whatever was found here was assumed to have come through descent or derivation. The conceptions of autogeny and of independent growth, by which men in the same plane of culture act and think alike, with only the modifications of environment, had not arisen to explain observed facts.

Many authors have contended that the North American Indians were descendants of the "ten lost tribes of Israel." Prominent among them was James Adair, whose work, highly useful with regard to the customs of the southeastern Indians, among whom he spent many years, was mainly devoted to proof of the proposition. The Rev. Ethan Smith is also conspicuous. Even the latest general treatise on the Indians, published last year, and bearing the comprehensive title, "The American Indian," favors the same theory.

The authors of the school mentioned rest their case on the fact, which I freely admit with greater emphasis, that an astounding number of customs of the North American Indians are the same as those recorded of the ancient Israelites. The lesson to be derived from this parallel is, however, very different from that drawn by those who have advocated the descent in question.

The argument, strongly urged, derived from an alleged similarity between Hebrew and some Indian languages, especially in identity of certain vocables, may be dismissed forthwith. Perhaps the most absurd of all the coincidences insisted upon by Adair was the religious use of sounds represented by him to be the same as the word Jehovah. The "lost" Israelites when deported did not use orally the name given in the English version as "Jehovah," and the mode of its spelling and pronunciation is at this moment in dispute, though generally accepted as Jahveh; therefore, it would be most extraordinary if the tribes of Indians supposed to be descendants of the lost ten tribes of Israel should at this time know how to pronounce a name which their alleged ancestors practically did not possess.

* Address of the Vice-President of the American Association for the Advancement of Science, Section H, Anthropology, delivered at the Toronto meeting, August, 1889.

Father Lafiteau was so much excited by coincidence in sound of some of the Iroquoian names and expressions with the language of the ancient inhabitants of Thrace and Lycia that he based thereon a theory of descent. On similar grounds ancestors of the Indians have been found among the Phœnicians, Scandinavians, Welsh, Irish, Carthaginians, Egyptians, Tartars, Hindus, Malays, Chinese, Japanese, and all the islanders of Polynesia. It is not wonderful that, with the choice of three hundred Indian languages, besides their dialects, from which to make selections of sounds, some one should be likened to some other language, for all spoken languages can in that manner—i. e., by a comparison of vocables—show identity of sound and a percentage of coincidences of significance. Philology now applies more discriminating rules of comparison.

But all arguments that the Indians are descended from the "lost tribes" are demolished by the fact, now generally accepted, that those tribes were not lost, but that most of their members were deported and absorbed, their traces remaining during centuries, and that others fled to Jerusalem and Egypt. If any large number of them had remained in a body, and had migrated at a time long before the Columbian discovery, but later than the capture of Samaria in the seventh century B. C., their journey from Mesopotamia to North America would have required the assistance of miracles that have not been suggested except in the Book of Mormon.

For brevity, the term "Indians" may be used—leaving the blunder of Columbus where it belongs—without iterating their designation as North American, though I shall not treat of the aboriginal inhabitants south of the United States. This neglect of Mexico and Central and South America is not only to observe my own limits, but because some of the peoples of those regions had reached a culture stage in advance of the northern tribes. To avoid confusion, the term "Israelites" may designate all the nation. Although the tribes became divided into the kingdoms of Israel and of Judah, when it is necessary to speak of the northern tribes they may be designated as the kingdom of Samaria. The shortest term, Jews, would be incorrect, as the people now scattered over the world and called "Jews" are chiefly the descendants of the southern branch or fractional part of the children of Israel, and have a special history beyond that common to them and their congeners.

The parallel presented is not selected because its two counterparts are more similar to each other than either of them is to other bodies of people among the races of the earth. A similar parallel can be drawn between both the Indians and the Israelites and the Aryan peoples, from which I and most of my hearers are supposed

to have descended. The selection is made for convenience, because this audience is assumed to be familiar with the Old Testament, so that quotations and citations from it are less necessary; and also because many of them in this, the Anthropologic Section, are familiar with the Indians, so that the collocation of facts without a prolix statement is sufficient for comparison.

Although the Indians are divided into fifty-eight linguistic stocks and three hundred languages, and although there is great variety in their manners, customs, and traditions, yet there is sufficient generic resemblance between all of them to afford typical instances, where European civilization and missionary influence have not effected serious change, or where the early authorities are reliable. It is essential to examine the other side of the parallel —the Israelites—at a period coincident in development with that of the Indians. That part of the history and records of the Israelites must be chiefly considered which relates to the times before they had formed a nationality and had become sedentary. The general use of writing was nearly contemporaneous with that nationality, and the era of King David is a proper demarkating line. The Indians never having arrived at the stage of nationality, though some of them (as the Iroquois and the Muskoki) were far on the road to it, and never having acquired a written language, their stage of culture at the Columbian discovery shows a degree of development comparable with that of the Israelite patriarchal period and the early Canaanite occupation before the rule of kings.

It is important to establish the time when writing was first known among the Israelites, because then their traditions would first become fixed. No reliable history can exist before writing. An illiterate people remembers only fables and myths; from these the history of the years before writing was used must be winnowed. There is no reason to suppose that the Hebrew language was written at the time of the exodus, though some such mnemonic system might have been invented as was used by several of the Indian tribes. If Moses had all the knowledge of the Egyptians, but no more, he could not have used any better mode of writing than their hieratic, in which it was not possible to write intelligibly any long document in the Hebrew language, simply because the advance made by the hieratic, in which the use of phonetics began, was not sufficient to express all the Hebrew vocables.

There has been an attempt to show that the old Hebrew alphabet, which has been classed as partly Phœnician and partly Babylonian, was obtained from Assyria at a time before the exodus, but the proposition is not yet established. Even if Assyrian characters adaptable to the Hebrew language did then exist, it is not probable that the Israelite herdsmen and bondmen did so

adapt them. If any one of them—e. g., Moses—had done so as an individual act, the feat would have had but one historic parallel, which would have furnished another coincidence between Israelite and Indian. It was performed by the Cheroki, Sequoia, who in less prosaic days would have become the hero of a Kadmos myth. But Sequoia left very distinct marks of his invention, while there is no evidence that the Israelites possessed an alphabet before they settled in Canaan, and there are strong inferences against that supposition.

The compilers of the Old Testament felt no doubt that the law could have been written on Sinai at the time of the exodus. They knew how to write and knew that their predecessors for several generations had written, so it did not occur to them that there had ever been a time in which persons of the higher classes were ignorant of writing.

It is probable that in the days of Samuel the Israelites had made some progress in the art of writing. An alphabet had been known to some of them before; but its common use is of greater consequence, and that depends much upon the substances used for writing, their cost, and the convenience of procuring them. The use, not the mere invention, of writing, not only divides the mythical and the historical periods, but reacts upon the character of the people in all their institutions, forming a new epoch in culture. The people did, perhaps, write under David at about 1100 B. C.

Moses flourished about fifteen centuries before Christ, and the oldest legends relating to him are, in their present shape, four or five centuries later than his death. He did not practically organize a new formal state of society, or if he did, temporarily, by his personal power, it had no direct consequence or historical continuity. The old system of clans and religions continued as before. If the legislative portion of the Pentateuch was the work of Moses, it remained a dead letter for centuries, and not until the reign of Josiah did it become operative in the national history.

The historical account undoubtedly states that Moses was, by inspiration, the founder of the Torah; but the question is, What was that Torah? It was not the finished legislative code. Long after the exodus a dramatic account was furnished of the promulgation of the whole law at Sinai to produce a solemn impression, and thus the code, which had slowly and imperceptibly grown during centuries, was represented as having been pronounced on one occasion celebrated by tradition as momentous.

The code now ascribed to Moses was a revised code, and in an unusual sense a mosaic work. When the Israelites attained the use of writing they did as all people in the world have done when they began to use writing—i. e., they wrote out their own myths, traditions, and legends as they knew them at the time of writing.

But during the long time in which the traditions were transmitted orally, the growth of the nation's ideas produced a change in them without any fabrication or design, and it is probable that the traditions affected only to this extent were set forth in the earlier documents, long since lost, namely, the "Book of the Wars of Jahveh" and the "Jasar." There were, however, special temptations in the later history of Israel, in the contests between the Elohists and the Jahvists, to manipulate the earlier documents. When the compilers belonging to the two schools produced the two versions, intermixed and confused in the books we now have, they differed from all people in history if the contestants, for political and personal power, did not color the records to suit their own views.

Students who have devoted their lives to the study of the last compilation have been able to identify, by linguistic and historical exegesis, the fragments of the original traditions, the epic tales of the first documents, the theocratic deductions and the later sacerdotal visions, though the two versions appear on the same page and sometimes in the same paragraph. The results of this immense labor by the Hebraists of this generation have lately been presented by Renan in a popular form. His works, as well as those of other authors whose names will be mentioned in this address, I have used freely, though generally without exact quotation.

In addition to the linguistic and historical tests, other internal evidences, especially the antedating of conceptions several centuries (some instances of which will be mentioned), show that the books, as now presented, were written long after the periods referred to in them.

The main document on the primitive age is the Book of Genesis, regarded for the reasons mentioned, not as literally historical, but as the tradition, written at a respectable antiquity, of an age that really existed. In examining it the historical part is discovered, not by belief in the miraculous, but by the proper comprehension of the mythical.

Much can be learned from myths and legends of the times anterior to strict history. The Homeric epics are not history, yet they throw a flood of light upon Greek life a millennium before the Christian era. The ante-Islam tales and the Arthurian and Niebelungen romances of the middle ages are not true in fact, yet they are storehouses, preserving the social life of the days when they were composed and to a less though still useful degree of the time embraced by the still earlier traditions. The generalizations derived from the details of ancient texts are truths obtained by induction.

It is expedient to make a disclaimer before entering upon the necessary comparisons of religions. I absolutely repudiate any

attack upon any religion. Let us learn a lesson from the Indians, not only in tolerance but in politeness. One of the early Jesuit missionaries in Canada recounts how he pleased a Huron chief by his discourse upon the cosmology set forth in the Scriptures, and felt that he had secured a convert until the chief, thanking him for his information, added, "Now you have told me how your world was made, I will tell you how my world was made"; and proceeded to give the now familiar story of the woman falling from the sky, and the turtle. He was willing that the priest should retain his belief, with which his own, in his opinion, did not conflict. Dr. Franklin tells of a Susquehannock who, after a similar lecture from a Swedish missionary, was answered in the same manner; but this missionary became angry and interrupted the Indian, whereupon the latter solemnly rebuked him with pity: "I have listened politely to what you told me; if you had been properly brought up, you would have believed me as I believed you."

Religion, as accurately defined, embraces only the perficient relations between divinity and man, and the mode in which such relations operate. Popularly it includes cosmology and theology. For present convenience the broad subject may be divided into Religious Opinions and Religious Practices.

In this comparison, all religious views personally entertained must be laid aside and the study conducted strictly within the scope of anthropology. Modern thinkers adopt the rule not to use a miraculous factor when unnecessary. *Nec deus intersit, nisi dignus vindice nodus.* It is now regarded as puerile to explain all puzzling phenomena, as was done for ages—

> "When solved complete was any portent odd
> By one more story or another god."

This attitude, however, is still not universal. When experience of observed facts and of the orderly working of the forces of nature are not sufficient for explanation, some minds yet resort to the miraculous. Others humbly confess ignorance and work for light. This light when gained is real and lasting, not the delusive hues of cloud-region, varying with each instant and to each observer's eye, and soon resolving into the same old mists and fogs from which escape was sought.

In their explanation of phenomena, all the peoples of the world have resorted to revelations. Every myth or early teaching is directly or indirectly through revelation; but as the revelation is on both sides of the equation, it can be eliminated from any parallel such as is now presented.

A cardinal of more than titular eminence was rash when, admitting that the doctrine of the devil and his command of demons was first learned by the Israelites during the Babylonian captiv-

ity, he insisted that it might be divine revelation, notwithstanding its immediate source. He said that if God made Balaam's ass speak, it would also be easy for him to provide that the heathen should give correct instruction. The non-existence of Satan is not demonstrable; so it may be well to examine into subjects on which we have knowledge, such as geology and astronomy. It appears from bricks in palaces at Nineveh that the Mosaic cosmology was also obtained from the same source as the Satanic doctrine. Any revelation on the subject would in order of time have been given to, and according to all evidence was promulgated by, the cultured Assyrians, not the ignorant captives. The priority, however, is of little moment, as the revolving dish-cover theory, whether as originally noted on clay or on rolls of sheep-skin, is now obsolete. All dependence on revelations practically means that those suiting us are true and all others false. When judgment upon the truth or falsehood of an alleged revelation can be made in accordance with the prejudices of the judge, the subject becomes too eclectic and elastic to be considered by science, or indeed by common sense.

The scope of anthropology is to study within the category of humanity. If theology comes from man's conceptions, it is embraced in anthropology. If theology is of divine origin, anthropology may discuss what men think and do about it. But the truth or falsity of revelation can not be dealt with in this address. To raise that point acts as a *clôture*, cutting off all debate.

Religious Opinions.—Religious writers have often explained the differences in beliefs among the various peoples of the world on the hypothesis that true religious knowledge was implanted at one time in the ancestors of all those peoples, and that the divergence now found is through decay of that supernatural information. The early missionaries to America, of all denominations, were imbued with this dogma and sought, and therefore found, evidences of the one primeval faith. Sometimes they limited themselves to the similar beliefs of the Indians and the Israelites, but often they passed beyond that stage to locate the vestiges of Christianity. These they said came by the hands of Christian pre-Columbian visitors, and one explanation was by the importation of the apostle Thomas. The coincidences found were exaggerated, but when facts were opposed they were not less satisfactory, as the adverse power of Satan then appeared. Such mental predetermination nearly destroys the value of those missionary accounts.

The most generally entertained parallel between the Indians and the Israelites, repeated by hundreds of writers, was that they both believed in one overruling God. This consensus, if true, would at once establish a beatific bridge of union between the two peoples, but its iris arch vanishes as it is viewed closely.

After careful examination, with the assistance of explorers and linguists, I reassert my statement, published twelve years ago, that no tribe or body of Indians, before missionary influence, entertained any formulated or distinct belief in a single, overruling "Great Spirit," or any being corresponding to the later Israelite or the Christian conception of God. All the statements of the missionaries and early travelers to the opposite effect are erroneous. Even some of the earliest writers discovered this truth. Lafiteau says that the names "Oki" and "Manito" were given to various spirits and genii. Champlain said that Oki was a name given to a man more valiant and skillful than common. Manito signifies "something beyond comprehension." A snake was often a manito, and seldom were snakes molested. "Hawaneu," reduced to correct vocables, only means loud-voiced—i. e., thunder. "Kitchi Manito" is not a proper name for one god, but an appellation of an entire class of great spirits. So with the Dakota term "Wakan," which means only the mysterious unknown. A watch is a wakan. The Chahta word presented as "God" for two centuries is now found to mean a "high hill."

Some Indians, perhaps, had a vague idea of some good spirit or being whom they did not worship and to whom they did not pray. They prayed and sacrificed to the active daimons, concerning whom they had many myths. In their various cosmologic myths there was sometimes a vague and unformulated being who started the machinery by which the myth proceeded; but when once started no further attention was paid to such originator. Perhaps some modern advanced thinkers have no clearer definition of a great first cause.

Praise has been lavished upon the Indians because they did not take the name of God in vain. The true statement, however, has a different significance. They did not, according to the best linguistic scholars, have any word corresponding with the English "God" either to use or misuse, and they deserve no more praise for avoidance of profanity than for their total abstinence from alcoholic drinks before such had been invented or imported. The terms too liberally translated as "Master of Life" and "Maker of Breath" were epithets merely. Perhaps there was an approach to a title of veneration when the method of their clan system was applied to supernatural persons, among whom there would naturally be a chief or great father of the "beast gods," on the same principle as there was a chieftaincy in tribes.

The missionaries who have persistently found what did not exist are not without excuse. Wholly independent of any design to force welcome answers, an interviewer who asks a leading question of an Indian can always obtain the answer which is supposed to be desired. The sole safe mode of reaching the Indian's men-

tal attitude is to let him tell his myths and make his remarks in his own way and in his own language. When such texts are written out, translated, and studied they are of great value. It is only within about twelve years that this has been done in a systematic manner, but it has already resulted in the correction of many popular errors.

In attempting to translate the epithets mentioned, the missionaries and travelers often honestly used the word which, in their own conception, was the nearest equivalent. An instructive example is where Boscana describes a structure in southern California as a "temple." It was a circular fence, six feet high, not roofed in—a mere plaza for dancing; but the dancing was religious, and the word "temple" was the best one he could find, by which mistake he has perplexed archæologists who have sought in vain for the ruins.

A consideration not often weighed is that the only members of the Indian tribes who are willing to give their own ideas on religious matters to foreigners are precisely those who are most intelligent and most dissatisfied with their old stories. There were minds among them groping after something newer and better, and it would be easy to translate their vague longings into the conception of an overruling Providence. But the people had made no such advance.

The missionaries who announced that the Indians were fixed in the belief in one god were much troubled by the statement of the converted native, Hiaccomes, of Martha's Vineyard, who, having enumerated his thirty-seven gods, gave them all up. This, however, was a typical instance of the truth. The Indians had an indefinite number of so-called gods corresponding with the like indefinite number of the Elohim of the Israelites before the supremacy of Jahveh.

The biblical religion of Israel has been popularly held to be coeval with the world, but its own beginning was by no means archaic. About a thousand years before Christ it did not exist, and at least four hundred years were required for its development. The religious practices of David and Solomon did not materially differ from those of their neighbors in Palestine. Not until the time of Hezekiah, about seven hundred and twenty-five years before Christ, did the Israelite religion attain to a distinct formulation. Its ordinances and beliefs advanced from crudity and mutation to ripeness and establishment. It was a system long in growth, and so could not early possess authoritative documents.

The nomad Semite believed, with other barbarians, that he lived amid a supernatural environment. The world was surrounded and governed by the Elohim—myriads of active beings,

seldom with distinct proper names, so that it was easy to regard them as a whole and confound them together. Yet the power bore different names in different tribes. In some cases it was called El, or Alon, or Eloah; in other cases Elion, Saddai, Baal, Adonai, Ram, Milik or Moloch.

The Elohim, though generally bound together, sometimes acted separately; thus each tribe gained in time its protecting god, whose function was to watch over it and direct it to success.

In the transition to nationality, the Israelites conceived a national god, Jahveh, who was not just, being partial toward Israel and cruel toward all other peoples. The worship of a national god is not monotheistic, but henotheistic, recognizing other gods of other peoples. The work of the later prophets consisted in restoring the attributes of the ancient elohism under the form of Jahveh, and in generalizing the religious cult of a special god.

Jahveh was not at first the god of the universe, but subsequently became so because he was the God of Israel, and very long afterward was claimed to be the only god, mainly because the Israelites claimed to be the peculiar people. Even down to the time of the prophet Isaiah, there was alternation of conflict and of co-ordination between Jahveh and the other gods of Canaan, especially Baal.

The revolution accomplished by the prophets did not change expressions. The concept of Jahveh was too deeply rooted to be removed, and the people spoke of Jahveh as they had formerly spoken of the Elohim. He thus became the supreme being who made and governed the world. In time even the name of Jahveh was suppressed and its utterance forbidden; and it was replaced by a purely theistic word meaning the Lord. Undoubtedly the prophets, at the time of the kings and later, taught the worship of one God, but the people were not converted to the doctrine until after the great captivity.

When established in Palestine, the Israelites entered into communion with the Canaanites, their kindred, and worshiped Baal. Later they frequently bowed down to the Dagon of the Philistines, probably because he was the god of their warlike victors. Solomon, perhaps from admiration of Sidonian culture, introduced the service of Astarte, which was intermitted; but later, Ahab established the worship of the Sidonian divinities in the kingdom of Samaria. It was subsequently readopted in the kingdom of Judah, and not until the reign of Josiah were the Sidonian altars finally demolished.

The true parallel, therefore, between the Indians and the Israelites, as to belief in a single overruling God, is not that *both*, but that *neither*, held it.

In the stage of barbarism all the phenomena of nature are

attributed to the animals by which man is surrounded, or rather to the ancestral types of these animals, which are worshiped. This is the religion of zoötheism. Throughout the world, when advance was made from this plane, it was to a stage in which the powers and phenomena of nature are personified and deified. In this stage the gods are anthropomorphic, having the mental, moral, and social attributes of men, and represented under the forms of men. This is the religion of physitheism. The most advanced of the Indian tribes showed evidence of transition from zoötheism to physitheism. The Israelites, in the latter part of the period selected, showed the same transition in a somewhat higher degree than the Indians did when their independent progress was arrested.

It is needless to enlarge upon the animal gods of the Indians, or to furnish evidence that they gave some vague worship to the sun, the lightning, to fire and winds.

There is no doubt that the Israelites were for a long period in the stage of zoölatry. They persisted in the worship of animal gods—the golden calf, the brazen serpent, the fish-god, and the fly-god. The second commandment is explicitly directed against the worship of the daimons of air, earth, and water, which is known to have been common; and the existence of the prohibition shows the necessity for it, especially as it was formulated, after the practice had existed for centuries, by a religious party which sought to abolish that worship.

The god of Sinai was a god of storm and lightning, which phenomena were strange to the Israelites after their sojourn in plains. The ancient local god of the Canaanites began in the exodus to affect the religious concepts of the Israelites, so that they associated Jahveh with the god whose lands they were planting and whose influence they felt. Sinai was thenceforward the locality of their theology. Jahveh, through all after-changes, remained there as his home; he spoke with the voice of thunder, and never appeared without storm and earthquake.

Another class of gods connected with beast-worship and also with the totemic institution (to be hereafter specially noted) was tutelar, the special cult of tribes, clans, and individuals. It was conspicuous both among the Israelites and the Indians.

Jahveh may first have been a clan or tribal god, either of the clan to which Moses belonged or of the clan of Joseph, in the possession of which was the ark. No essential distinction was felt to exist between Jahveh and El, any more than between Ashur and El. Jahveh was only a special name of El, which had become current within a powerful circle, and which, therefore, was an acceptable designation of a national god. When other tutelar gods did not succeed, there was resort to Jahveh, probably in the early in-

stances because he was the most celebrated of all the tutelar gods, and the reason for that celebrity was that the most powerful of the clans claimed him as tutelar.

Hecastotheism is a title given to the earliest form of religion known, which belongs specially to the plane of savagery. In it every object, animate or inanimate, which is remarkable in itself or becomes so by association, is a *quasi* god. The transition between savagery and barbarism, as well as between the religions of hecastotheism and zoötheism, connected with them, was not sharply marked, so that all their features could coexist at a later era, though in differing degrees of importance.

This intermixture is found both among the Israelites and Indians. An illustration among many is in the worship of localities and of local gods. Conspicuous rocks, specially large trees, peculiar mountains, cascades, whirlpools, and similar objects received worship from the Indians; also the places where remarkable occurrences, as violent storms, had been noted; and among some tribes the particular ground on which the fasting of individuals had taken place, with its accompanying dreams. The Indians frequently marked these places, often by a pile of stones. The Dakotas, when they did not have the stones, used buffalo skulls.

In the Old Testament frequent allusions are made to a place becoming holy where dreams or remarkable events had occurred. They were designated by pillars. The Israelite compilers adopted the pillar of Bethel for the same reason that required Mohammed to adopt the Caaba. Though struggling for monotheism, they could not always directly antagonize the old hecastotheism.

Future State.—The topic of a future state may be divided into (1) the simple existence of the soul after death, (2) the resurrection of the body, and (3) a system of rewards and punishments in the next world.

The classical writers often distinguished two souls in the same person—one that wandered on the borders of the Styx until the proper honors had been given to the corpse; the other being a shadow, image, or simulacrum of the first, which remained in its tomb or prowled around it. The latter could be easily invoked by enchanters.

Some of the Indians thought that the souls of the dead passed to the country of their ancestors, from which they did not dare to return because there was too much suffering on the road forward and backward. Nevertheless, they believed that there was something spiritual which still existed with their human remains, and they tell stories of it. Thus there are two souls, and the Dakotas have four, one of which wanders about the earth and requires food, the second watches over the body, the third hovers around the village, and a fourth goes to the land of spirits.

The Iroquois and Hurons believed in a country for the souls of the dead, which they called the "country of ancestors." This is to the west, from which direction their traditions told that they had migrated. Spirits must go there after death by a very long and painful journey, past many rivers, and at the end of a narrow bridge fight with a dog like Cerberus, and some may fall into the water and be carried away over precipices. This road is all on the earth; but several of the Indian tribes consider the Milky Way to be the path of souls, those of human beings forming the main body of the stars, and their dogs, which also have souls, running on the sides. In their next world the Indians do the same as they customarily do here, but without life's troubles.

The Israelites believed in a doubling of the person by a shadow, a pale figure, which after death descended under the earth and there led a sad and gloomy existence. The abode of these poor beings was called Sheol. There was no recompense, no punishment. The greatest comfort was to be among ancestors and resting with them. There were some very virtuous men whom God carried up that they might be with him. Apart from these elect, dead men went into torpor. Man's good fortune was to be accorded a long term of years, with children to perpetuate his family and respect for his memory after death.

The Indians did not believe in existence after death in a positive and independent state. The spirit does not wholly leave the body and the body is not resurrected. Perhaps a good commentary upon their belief is furnished by a tribe of Oregon Indians who, hearing missionaries preach on the resurrection, immediately repaired to an old battle-field and built great heaps of stones on the graves of their fallen foes to prevent their coming up again. They did not want any of that.

Among the Israelites the resurrection of the body was a foreign idea imbibed during the captivities in Assyria and Babylonia. Perhaps the first reference made to it is in the prophet Daniel. It was not fully believed in so late as the procuratorship of Pontius Pilate.

Among the Indians privation of burial and funeral ceremonies was a disgraceful stigma and cruel punishment. There was trouble about children who died shortly after their birth, and also about those whose corpses were lost, as in the snow or in the waters. In ordinary cases of death the neglect of full and elaborate ceremonies caused misfortune to the tribe.

The story of the "happy hunting-ground" among the Indians has not been generally apprehended. As regards what we now consider to be moral conduct there was no criterion. A good Indian was one who was useful to his clan and family, and at the time of his death was not under charges of violating the clan rules,

for which the Polynesian word *tabu* has been adopted. The moral idea of goodness of a Pani chief is to be a successful warrior or hunter. The actual condition at the moment of death decided the condition in the future far more than any conduct during the past. In the portions of the continent where the scalp was taken, the scalped man remained scalped in the world of spirits, though some tribes believed that scalping prevented his reaching that world. If he had but one leg or eye here, he had but one leg or eye afterward. In tribes where they cut off the ears of slain foes the spirit remained without ears. A special instance is where the victim was considered too brave to be scalped, but the conquerors cut off one hand and one foot from the corpse to keep him from inflicting injury upon the tribe of the conquerors in the next world. Some of the tribes thought that if an Indian died in the night he remained in total darkness ever afterward.

One of the most curious of their beliefs was in connection with drowning and hanging, the conceit being that the spirit (which was in the breath) did not escape from the body. This doctrine was made of special application to prevent suicide, which was generally performed either by hanging or drowning, the deduction being that suicides could not go to the home of the ancestors.

It is probable that the various trials which the spirit is supposed to undergo before reaching the other world were devised to secure confidence in the absence thereafter of the ghosts of the dead, because the same difficulty would attend their return. As without the assistance of mortuary rites the ghosts would not be able to reach their final home, their permanent absence was secured because there were no repetitions of those rites to assist their return. Fear of the ghosts, not only of enemies but of the dearest friends, generally prevailed. After a death all kinds of devices were employed to scare away the spirit. Sometimes a new exit, through which the corpse was taken, was cut through the wigwam and afterward filled up, it being supposed that the spirit could re-enter only by the passage through which it went out. Sometimes the whole wigwam was burned down. There was often a long period, which travelers called that of mourning, during which drums and rattles were used to drive away the spirits. After firearms were obtained, they were discharged in and around the late home of the deceased with the same object. The loud cries of so-called lamentation had probably a similar origin, and this is more marked when the lamenters were strangers to the dead, and even professionals, not unlike the Irish keeners.

In this general connection it is proper to allude to the common abstinence from pronouncing the true name of any dead person. This is more distinct than the sociologic custom where the man's true name should not be used in his life except on special occa-

sions. There was some fear that, by calling his name, he might come back.

It would be wrong to accuse the Indians of want of feeling indicated by their horror of the dead. In one of the most ancient accounts—that of Cabeza de Vaca—it is declared that the parents and other relatives of the sick show much sympathy while life remains, but give none to the dead—do not speak of them or weep among themselves, or make any signs of grief or approach the body. This domestic reticence is entirely different from, but not antagonistic to, the obligatory mortuary rites which were practiced.

To secure the living from the presence of the spirits of the dead was the first object, and the second was to assist those spirits in the journey to their destination. These were the prevailing ideas of all the mortuary customs of the Indians. It may be true that there was in some cases (though missionary influence is to be suspected) a belief that there were two different regions in which the bad and the good would severally remain, but that was not of general acceptance. There was but one future country, and the only question was whether the spirits got there or not. There was no hell.

The Israelites, in their sacred books, do not show the influence of fears or hopes concerning a future state with reference to individual morality. Among them death at any age was not an inevitable necessity, as they thought that life might be prolonged to an indefinite extent, but it was inflicted as a punishment and their signs of mourning were acts of penitence and contrition, with the idea that the survivors might have been the cause of the death. All deaths were classed with public calamities, such as pestilence, famine, drought, or invasion, being the work of an enemy—perhaps a punishing god, perhaps a daimon or a witch. They regarded it so great an evil to die unlamented that it was one of the four great judgments against which they prayed, and it was called the burial of an ass. These are the inferences to be derived from the books as we have them. It is, however, questionable whether rites attending upon death were not with them similar in intent to those of the Indians—i. e., to provide, by means of those rites, for the future welfare of the departed, rather than in accordance with our modern sentiment, to show respect and personal sorrow. Passages of the Old Testament may be noted—e. g., the one telling how the bodies of Saul and his children were rescued from Bethshan and taken to Jabesh, where they were burned and the bones buried. The ceremony in this case and others seems to have been the burning of the flesh and the burial of the bones, as was frequently done by the Indians on occasions of haste, without waiting as usual for the decay of the flesh, the later gathering of the bones being at stated periods of years.

There is no evidence that the Israelites feared the corpse and

its surroundings beyond that to be inferred from the ordinances concerning pollution, which, however, are significant.

RELIGIOUS PRACTICES.—There should always be a cross-reference in thought between what in time became a religious practice and the earlier sociology, to be mentioned in its place, with which it was closely connected.

Josephus remarks about the Israelites that "beginning immediately from the earliest infancy, nothing was left of the very smallest consequence to be done at the pleasure and disposal of the person himself."

The same is true regarding the Indians. Their religious life is as intense and all-pervading as that of the Israelites. It is yet noticed in full effect among tribes as widely separated, both by space and language, as the Zuñi and the Ojibwa, and their practices are astonishingly similar in essence and even in many details to some of those still prevailing in civilization.

Among the Hurons and Iroquois there were religious rites for all occasions, among others for the birth of a child, for the first cutting of its hair, for its naming, and for its puberty, for the admission of a young man into the order of warriors, and the promotion from warrior to chieftain, for making a mystery-man, for first using a new canoe, for breaking tillage-ground, for sowing and harvest, for fixing the time to fish, for deciding upon a war-like expedition, for marriages, for the torturing of captives, for the cure of disease, for consulting magicians, invoking the daimons, and lamenting the dead.

Shamans.—Among the Indians there was frequently an established and recognized priesthood, provided by initiation into secret religious societies, corresponding in general authority to that of the Levites, although the order of the latter was instituted in a different manner, perhaps imitated from the exclusive class of the priesthood in Egypt. The shamans in all tribes derived a large part of their support from fixed contributions or fees.

Adair describes a special ceremony for the admission or consecration of a priest among the southern tribes, as follows: "At the time of making the holy fire for the yearly atonement of sin the Sagan clothes himself with a white ephod, which is a waistcoat without sleeves, and sits down on a white buckskin, on a white seat, and puts on it some white beads, and wears a new pair of white buckskin moccasins, made by himself, and never wears these moccasins at any other time."

Similar exclusive use by the high priest of the garments used on the day of the atonement is mentioned in Leviticus.

In addition to the organized class referred to, there were other professional dealers in the supernatural who may be called conjurers, sorcerers, or prophets. They were independent of and often

antagonistic to the regular shamans. Instance the Jossakeed of the Ojibwa, rivals of the Midé, as the Israelite prophets were of the Levites. At the time of the Judges the prophets were isolated and without any common doctrine. These irregular practitioners arrived at recognition individually by personal skill in an exhibition of supernatural power—that is, they wrought miracles to prove themselves genuine.

At the time of the exodus there were, among all the Semitic tribes, sorcerers who possessed mysterious secrets and enjoyed some of the power of the elohim. They were paid to curse those whose ruin was desired. Balaam was the most distinguished sorcerer of that time.

One of the most frequent purposes for employing supernatural agency was to bring on rain in time of drought. The practitioner generally tried to delay his incantations as long as possible in hopes of a meteorologic change. Sometimes, on failure, he was killed, as he was supposed to be an enemy who possessed the power he professed but was unwilling to use it; and to prevent this dangerous ordeal in a dry season, he charged in advance certain crimes and "pollutions" against the people, on account of which all his skill would be in vain. The more skillful rain-makers among the Sioux and the Mandans managed not to be among the beginners, but toward the last of the various contestants. The rain would surely come some time, and when it came the incantations ceased. The shaman who held the floor at the right time produced the rain.

Frequent reference to rain-making is found in the Old Testament, in which the prophets were the actors.

The mystery-men were consulted on all occasions as sources of truth, not only to explain dreams, but to disclose secrets of all kinds; to predict successes in war; to tell the causes of sickness; to bring luck in the hunt or in fishing; to obtain stolen articles; and to produce ill luck and disease. Their processes, together with thaumaturgic exhibitions, included some empiric knowledge, and also tricks of sleight-of-hand and hypnotic passes.

The Chahta had a peculiar mode of finding the cure for disease, by singing successively a number of songs, each one of which had reference to a peculiar herb or mode of treatment. The preference of the patient for any song indicated the remedy.

The Israelites believed that diseases as well as accidents without apparent cause, and other disasters, were the immediate acts of the elohim or were caused by evil spirits; therefore they relied upon prophets, magicians, or enchanters for exorcism. Hezekiah's boil was cured by Isaiah. Benhadad, King of Syria, and Naaman, the Syrian, applied to the prophet Elisha. All the people resorted to their favorite mystery-men.

Even so late as the time of Josephus it was believed that Solomon had invented incantations by which diseases were cured, and some handed down by tradition were commonly used. Incense banished the devil, which also could be done by the liver of a fish. Certain herbs and roots had the same power. Their medical practices might be recited, with slight change of language, as those of the Indians. The further back examination is made into savagery and barbarism, the more prevalent faith-cure appears.

Witches.—The Indians were in constant dread of witches, wizards, and evil spirits; but the activity of the good spirits was not so manifest. They, however, told Adair how they were warned by what he calls angels, of an ambuscade, by which warning they escaped. Bad spirits, or devils, were the tutelar gods of enemies, to be resisted by a friendly tutelar. The idea of a personal Satan was not found before the arrival of the missionaries.

Among the Indians witches were often indicated by the dreams of victims. They were sometimes killed merely upon accusation, and it is interesting to notice, with relation to comparatively modern history, that the accused frequently confessed that they were sorcerers, and declared that they could and did transform themselves into animals, become invisible, and disseminate disease.

A sufficient reference to the Israelites in this connection is to quote the ordinance, "Thou shalt not suffer a witch to live." This injunction, in the higher civilization, is observed by destroying the idea that witches live, ever have lived, or ever can live.

Dreams and Divinations.—The topics of inspiration by dreams and divination by oracles may be grouped together.

The Indians supposed that with, and sometimes without, a special fasting, and other devices to produce ecstasy, the spirits or daimons manifested themselves in dreams. It was sometimes possible in these dreams for the soul to leave the body, and even to visit the abode of departed spirits.

Among the Iroquoian tribes the suggestions made by dreams were implicitly followed, not only by the dreamer, but by those to whom he communicated his dreams. For instance, an Iroquois dreamed that his life depended upon his obtaining the wife of a friend, and, though the friend and his wife were living happily, and parted with great reluctance, the dreamer had his wish. The same tribe had a special feast which was called the "feast of dreams," and partook of the nature of Saturnalia. Every object demanded by the dreamers must be given to them. In some instances they were unable to remember their dreams, and the special interposition of the mystery-men was invoked to state what their dreams were in fact and what was their significance.

Among the invaluable reports of the Jesuit missionaries, one

in 1639 gives the general statement that the Indians consulted dreams for all their decisions, generally fasting in advance; that, in fact, the dream was the master of their lives; it was the god of the country, and dictated their decisions concerning important matters—hunts, fishing, remedies, dances, games, and songs.

The belief in revelations through dreams was universal, and the power of explaining them was also by revelation. Their legends on this subject recall those about Joseph and Daniel. In addition, Job xxxiii, 15, 16, may be quoted:

"In a dream, in a vision of the night, when deep sleep falleth upon men, in slumberings upon the bed,

"Then He openeth the ears of men and sealeth their instruction."

And in Deuteronomy a prophet is equivalent to a dreamer of dreams.

There were various oracles among the Indians. Those most interesting to me are connected with pictography. Among many tribes, especially the Mandan, Hidatsa and Minnitari, after certain fasts and exercises, hieroglyphics deciding the questions which had been propounded appeared next morning on rocks. They were deciphered by the shaman who had made them.

The apparatus by which Jahveh was consulted was the urim and thummim, a form of oracle described as connected with the ark. It ceased to be known in the fifth century before Christ, and is now but vaguely understood. From the description and tradition it could, physically, have been worked by a custodian.

Severe fasts were probably the most common religious practices of the Indians. These were continued until they saw visions, sometimes sought for personal benefit as deciding upon their names to be adopted from the advent of a guardian spirit, and sometimes for tribal advantage. The doctrine of all of them, as Father Lafiteau quaintly observes, was the same that prevailed among many people of his day, to lead the mind from gross and carnal obstructions of the body. The real effect was to produce mental disorder. This ecstasy obtained by fasting was often accelerated by profuse sweating and the use of purgative or emetic drinks. Violent and prolonged exercise by dancing in a circle until the actors dropped in a swoon sometimes concluded the ceremonies.

The Israelite prophets were excited to inspiration by external means, such as dances and orgiastic proceedings resembling those of the dervishes and those of the Indian mystery-men. Music was a general accompaniment of the ecstasy. When they were about to prophesy, they wrought themselves into a condition of frenzy. When Elisha sent one of the children of the prophets to anoint Jehu, it was said of him, "Wherefore cometh this mad fellow?"

Pollution and Purification.—The subject of pollution and purification has been much and properly insisted upon as affording a striking parallel between the Israelites and the Indians. The Indians made special huts for the women, at certain periods, when they were considered so unclean that nothing which they touched could be used. A Muskoki woman, after delivery of a child, was separated from her husband for three moons (eighty-four days). This may be compared with the Levitical law by which the mother of a female child was to be separated eighty days and of a male forty days. Dr. Boudinot says that in some Indian tribes there was similar distinction between male and female children.

Among the southern Indians wounded persons having running sores were confined beyond the village, and kept strictly separate, as by the Levitical law. An Israelite dying in any house or tent polluted all who were in it and all the furniture in it, and this pollution continued for seven days. All who touched a corpse or a grave were impure for the same time. Similarly, many of the Indians burned down the house where there had been a death.

Many writers have asserted, as one of the excellences of the Israelite customs, that the "purification" imposed upon those who had been engaged in a burial was a sanitary regulation, a measure rendered expedient in a hot country. As no great proportion of the Israelites generally inhabited a country hot to the degree indicated, and as none of them had any conception of disease or the cause of death, this explanation is hardly sufficient. Much later the compilers might have gained some sanitary knowledge by which the old superstition was utilized. Its true explanation is from supernatural, not from natural, concepts. It is probably connected with a point mentioned before—i. e., the avoidance of corpses from the fear of the spirit of the dead and of the bad spirit which had caused the death, and the purificatory ceremony was for the daimon, not for the disease. The neglect of sanitation is well illustrated among the Navajo, who are little affected by civilization. Upon the death of one of their members they block up the shelter containing the corpse, and, from fear of the spook or of the agent of death, or of both, not from fear of the corpse itself, they never again visit it. Other tribes simply piled stones on the corpse, which prevented its disturbance by beasts, but did not absorb the effluvium. Still others exposed the dead on scaffolds. To leave corpses to putrefy freely is certainly not a sanitary measure, yet it was a practice existing together with the mortuary rites before mentioned, though many of the tribes practiced earth-burial, and a few used cremation.

On a broad examination of the topic of "pollution," so styled by most writers, it seems to be best explained by our recent understanding of *tabu*.

Sacrifice.—Man once imagined forces superior to himself, who yet could be invoked and moved to and from any purpose. The divine world was produced in his own image, and he treated its gods as he liked to be treated by his inferiors. He believed that the way to placate the forces surrounding him was to win them over as men are won over, by making presents to them. This clearly continued among the Israelites until the eighth century B. C., but it is to be regarded as a stage succeeding a former condition of zoölatry and totemism, without notice of which its details can not be understood.

Most people sacrificed to their divinities plants, fruits, and herbs, and animals taken from their flocks. People who had no domestic animals offered those taken in the hunt. The Indians offered the maize from their fields and the animals of the chase, and threw into the fire or water tobacco, or other herbs which they used in the place of tobacco. Sometimes these objects were hung up in the air above their huts. The northern Algonquins tied living dogs to high rods, and let them expire. In a similar manner other Indians stuck up a deer, especially a white deer, on poles. The plains tribes gave the same elevation to the head or skin of an albino buffalo on mounds, not having poles convenient. The spotless red heifer of the Israelites may be compared with the spotless white animals of the chase.

The southern Indians always threw a small piece of the fattest of the meat into the fire when eating or before they began to eat. They commonly pulled their newly killed venison several times through the smoke of the fire—perhaps as a sacrifice, and perhaps to consume the life-spirit of the animal. They also burned a large piece and sometimes the whole carcass of the first buck they killed, either in the winter or the summer hunt. The Muskoki burn a piece of every deer they kill.

The Israelites offered daily sacrifice, in which a lamb (except the skin and entrails) was burned to ashes. In some of their sacrifices there was not only distinction between animals that were fit and unfit, but in the manner of treatment. Sometimes the victim was not to be touched, but should be entirely consumed by fire. In others the blood should be sprinkled around the altar and the fat and the entrails burned, the remainder of the body to be eaten by the priests. But it was a crime to eat flesh that had been offered in sacrifice to a false god—i. e., god of another people.

The offering of the first-fruits, and therefore of the first-born, to the divinity, was one of the oldest ideas of the Semites. Moloch and Jahveh were conceived as being the fire, devouring whatever was offered to it, so that to give to the fire was to give to the god. In time, a substitute was suggested; the first-born was replaced by an animal or a sum of money. This was called the "money of the lives."

The "green-corn dance," common to many Indian tribes, is essentially the same ceremony of thanksgiving, or, more correctly, rejoicing with payment, for the first-fruits of the earth. Adair says that at the festival of the first-fruits the Southern Indians drank plentifully of the *cusseena* and other bitter liquids, to cleanse their bodies, after which they bathed in deep water, then went sanctified to the feast. Their annual expiation of sin was sometimes at the beginning of the first new moon in which their corn became full-eared, and sometimes at the recurrent season of harvest. They cleansed their "temple" and every house in the village of everything supposed to pollute, carrying out even the ashes from the hearths. They never ate nor handled any part of a new harvest till some part of it had been offered up; then they had a long fast "till the rising of the second sun." On the third day of the fast the holy fire was brought out from the "temple," and it was produced, not from any old fire, but by the rubbing of sticks. It was then distributed to the people.

Lafiteau says that the first animal the young hunter kills he burns with fire as a sacrifice. Another festival was a kind of holocaust, where nothing of the victim was left, but it was all consumed, even to the bones, which were burned. There were also feasts of first-fruits.

The Dakotas allowed no particle of the food at any of their religious feasts to be left uneaten. All bones were collected and thrown into the water, that no dog might get them or woman trample over them. It was a rule among many of the tribes that no bones of the beast eaten should be broken. There is no doubt that this was connected with zoölatry, and was intended to prevent anger on the part of the ancestral or typical animal, the result of which would be the disappearance of the game. There were many other ceremonies of the same intent. When the Mandans had finished eating, they often presented a bowlful of the food to a buffalo-head, saying, "Eat this," evidently believing that, by using the head well, the living herds of buffalo would still come and supply them with meat.

It is probable that what many authors have called the "day of atonement" or "expiation" was really a general wiping out of offenses—a settlement of accounts between individuals and particularly between clans, after which there should be no reprisal. This is illustrated by a peculiar ceremony among the Iroquois, strongly resembling the scapegoat of the Israelites. A white dog, before being burned at the annual feast, was loaded with the confessions or repentings of the people, represented by strings of wampum. The statute of limitations then began to operate.

In the Jahvistic version, the passover, an old festival held in the

spring, was historically connected with the departure from Egypt. The ceremonies are too well known to require narration, but will readily be compared with those of the Indians.

Incense.—The use of incense among Indians was the same as among Israelites—i. e., to bring and to please the spirit addressed. A genuine instance among the Iroquois was where tobacco was offered as late as 1882, and in archaic formal language still preserved, translated as follows:

Address to the fire: "Bless thy grandchildren, protect and strengthen them. By this tobacco we give thee a sweet-smelling sacrifice, and ask thy care to keep us from sickness and famine."

Address to the thunder: "O grandfather! thou large-voiced, enrich and bless thy grandchildren; cause it to rain, so that the earth may produce food for us. We give this tobacco, as thou hast kept us from all manner of monsters."

The Dakotas not only burned tobacco in their "buffalo medicine" to bring the herds, but often fragrant grass. Other tribes burned the leaves of the white cedar. These forms of incense were sometimes used to entice the inimical spirits, the shaman being supposed to be able, when they had arrived in the form of a bear or some other animal, to kill them with his rattle. Some of the Indians believed that incense and sacrifices generally were to be used only for the spirits from whom they feared harm. They said it was not necessary to trouble themselves about the good spirits, who were all right anyhow.

Fetiches.—Among many of the tribes of Indians there is a tribal totem (and often several clan totems) which, in later times becoming chiefly symbolic and emblematic, was once used in objective form for the most important religious purposes. Particularly, it was carried on extensive warlike expeditions. Adair, who calls it an "ark," describes it as made of pieces of wood, fastened together in the form of a square, to be carried on the back. It was never placed on the ground, nor did the bearers sit on the earth even when they halted. In many other tribes it was a bag of skins and its contents varied, but generally were "blessed" or "sacred" fragments of wood, stone, or bone. Among the Omaha it was a large shell, covered with various envelopes, and was never wholly exposed to sight, for that would occasion death or blindness.

A custodian was appointed every four years by the old men of the Blackfeet, to take charge of the sacred pipe, pipe-stem, mat, and other implements, which he alone was permitted to handle.

The ark of the Israelites was probably derived from the Egyptians, who had a real ark which was carried on the shoulders of the priests in processions. When the exodus began, the Egyptian ark for convenience was changed into a chest fitted with staves

for bearers. It became the standard of their warring and wandering life.

In addition to what has been called the ark or tribal fetich, the mystery-bag that each Indian had is to be compared with the Israelite teraph, which was a family or tutelary fetich independent of the national worship, and later was the subject of frequent denunciation. It was probably made of carved wood, and was often carried on the person, but was generally held as a household god or domestic oracle. The teraphim markedly resembled the Roman *penates*.

This comparison is explanatory of the statement that neither the Israelites nor the Indians worshiped idols. Its truth depends upon what is considered to be an idol. If the definition is limited to the human form the assertion is true, because their religion was not anthropomorphic; but fetiches were certainly the objects of worship, the recrudescent forms of which, appearing even in civilization, have been amulets, lucky-stones, pieces of wood and charms.

Sabbath.—It is not possible, in discussing the Israelites, to neglect the institution of the Sabbath. The four quarters of the moon made an obvious division of the month, and wherever the new moon and full moon are made religious occasions there comes a cycle of fourteen or fifteen days, of which the week of seven or eight days forms half. It is significant that in the older parts of the Hebrew Scriptures the new moon and the Sabbath are almost invariably mentioned together. Among the Israelites, and perhaps among the Canaanites, joy on the new moon became the type of religious festivity in general. There is an indication that in old times the feast of the new moon lasted two days, so that an approximation to regular recurrence of the subdivisions constituting the week was gained. The Babylonians and Assyrians had an institution dividing the month into four parts, by which, on the days assigned, labor was forbidden; but originally the Israelites' abstinence from labor was only incidental to their not working at the same time that they were feasting. While they were nomads, with only intermittent work, they had no occasion for a fixed day of rest.

The new moons were at least as important as the Sabbath until the seventh century before Christ. When the local sacrifices were abolished and the rites and feasts were limited to the central altar, which practically could be visited only at rare intervals, the general festival of the new moon ceased. The Sabbath did not, but became an institution of law divorced from ritual. The connection between the week of seven days and the work of creation is now recognized as secondary. The original sketch of the decalogue probably did not contain any allusion to the creation, and it

is even doubtful whether the original form of Genesis distributed creation over six days.

Subsequent history of the Sabbath shows a reflex action between religion and sociology. Religion prevailed against better arrangements for periods of rest. Sociology used religion to get what it could.

The Indians reached only the first part of the inception of the Sabbath in the ceremonies of the new and full moon, which were to them of great importance, those of the new moon being most noted.

Circumcision.—This, generally regarded as a distinctive mark of the Israelites, is by no means peculiar to them, and is found in so many parts of the world, with such evidences of great antiquity, as to contravene its attribution to them. Its origin is a subject of much dispute. As practiced indiscriminately in infancy, it is perhaps a surgical blunder. It is certain that among the Israelites it was not at first a religious rite. The operation was not then performed by the priesthood, but by a secular person of skill, without ceremonials. Afterward it was regarded as an initiatory ceremony, and as such its parallels connected with the sexual organization may be found all over the world, but as a special national distinction the declared object was not attained. Besides the Egyptians, Arabs and Persians, with whom the coincidence might be expected, many tribes of Africa, Central and South America, Madagascar, and scores of islands of the sea, show the same mark, and it has even been found in several of the North American tribes. The sole motive for alluding to this very comprehensive subject is to correct the popular belief that the custom is peculiar to the Israelites. In this as in many other alleged respects they were not "peculiar."

IS THE HUMAN BODY A STORAGE-BATTERY?

By HYLAND C. KIRK.

HON. J. W. DOUGLASS, a lawyer of Washington, D. C., formerly Commissioner of Internal Revenue, after reaching his office one morning, to relieve the pressure on his foot, took off one of his new boots and sat at his work, his legs crossed in the customary legal form, his stockinged foot swinging freely. It happened to swing over the waste-basket, when, to his exceeding surprise, every piece of paper, string, and scrap in that receptacle, as if impelled by a writ of *habeas corpus*, rose up and clung to his foot. He brushed off the scraps and tried it again, and again that peremptory mandamus or process of attachment seemed to

issue from his pedal extremity, and again the "poor white trash" of the waste-basket joined issue with the stocking. He was in a condition of excellent health and spirits that morning, and in a mood for experimenting: he removed his remaining boot, and secured a similar result with the other foot; when, congratulating himself on the fact that he seemed to be a very attractive person, he returned to his work.

An incident of this kind, though more startling in its outcome, is related as occurring in the same city more than eighty years ago, in a letter of a United States Senator, Dr. Samuel L. Mitchell. The letter is dated at Washington, March 17, 1802. He says: "A very singular occurrence has happened to General Dayton, of Elizabethstown, one of the New Jersey Senators. He pulled off his stockings of silk, under which were another pair of woolen gauze, just as he was going to bed. The former were dropped on the small carpet by the bedside, and the latter were thrown to some distance near its foot. Electrical snaps and sparks were observed by him to be unusually prevalent when he took off his stockings. He slept until morning, when the silk stockings were found to be converted to coal, having the semblance of sticks and threads, but falling to pieces on being touched. There was not the least cohesion. One of the slippers, which lay under the stockings, was considerably burned. One of the woolen garters was also burned in pieces—the carpet was burned through to the floor, and the floor itself was scorched to charcoal. It was a case of spontaneous combustion—the candle having been carefully put out, and there being very little fire on the hearth, and both of them being eight feet or more from the stockings."

Dr. R. D. Mussey, Professor of Surgery in Dartmouth College, in the "American Journal of Medical Sciences" for January, 1838, gives an account of a Mrs. B—, a married lady about thirty years of age, residing in Grafton County, New Hampshire, who gave out sparks and snaps continuously for some thirteen weeks, when this power was entirely lost and did not return again. The discovery of this faculty was a great surprise to the lady, and subsequently caused her some annoyance. Though Mrs. B— wore a silk dress at the time of the commencement of the phenomenon, this was exchanged for cotton and flannel successively without affecting the result; and the manifestations were found to be due to the lady's own person, and not to the clothing or other conditions. Dr. Mussey's account is supported also by Dr. W. Hosford, the lady's family physician.

Phenomena of this sort, when manifested, do not seem to be confined to any one portion of the human body, though occasionally localized. A Capuchin friar is mentioned by Dr. Schneider, whose scalp was a veritable reservoir of electricity. Whenever

he removed his cowl a number of "shining, crackling sparks" would pass from his bald pate; and this phenomenon, which was definite and strong while the monk was in good health, continued perceptible after three weeks' illness.

The case of Angélique Cottin has been frequently referred to. She was a French peasant girl, fourteen years of age, and possessing excellent health at the time her singular powers were discovered. She resided in the Commune of La Perrière, department of Orne, and with three other young girls was engaged in knitting ladies' silk-net gloves. Suddenly the oak weaving-frame was thrown down. The girls put it up; and almost instantly it was again upset. It was soon discovered that, whenever the girl Cottin touched her warp, the frame was agitated, would move about, and then, without apparent cause, be thrown violently back. Subsequently chairs, tables, lighted fire-wood, brushes, books, tongs, shovels, scissors, and other metallic articles were all set in motion whenever this girl approached them. The girl was very imperfectly educated and her friends were of limited intelligence, so it was not remarkable that, in 1846, such phenomena should be attributed to sorcery. The case was investigated by a number of scientific gentlemen, including M. Arago, who were shocked, as well as startled, and gave surprising accounts of her powers. Some time after, however, she was taken to Paris and examined by the *savants* of the Academy, and nothing of a surprising character was discovered. She had simply lost the power she formerly possessed.

The manifestations of Miss Lulu Hurst, of Georgia, will be recalled. A tall, large-boned, well-developed, good-looking country girl, reared on a farm, without any knowledge of occult forces, and among people almost wholly uninterested in scientific subjects, suddenly seems to possess a peculiar force, and the furniture begins to manifest unusual qualities when Miss Hurst is present, phenomena occurring not unlike those attributed to the French girl of La Perrière. This power, which was considerable in the outset, gradually waned, until her public exhibitions were quite unsatisfactory.

The writer was one of the committee who, on her first appearance at Wallack's Theatre, New York, had opportunity to investigate Miss Hurst. One test was as follows: Three gentlemen, among whom was a professor of athletics, each using both hands, held a billiard-cue above their heads in the air; Miss Hurst, by placing her hands flat on the top of the cue, brought it down without apparent muscular effort. At that time all power of repelling articles without contact seemed to have left her; but her success in collapsing umbrellas held by a reporter, and in lifting and repelling chairs by lightly touching them, was quite extraordinary.

During these performances she kept up a low, nervous giggle, and did not seem especially fatigued at the close.

Other Georgia women developed similar powers about the same time, or shortly after Miss Hurst's peculiarity became known. Miss Mattie L. Price, living in the same neighborhood, was one of these, and Mrs. C. F. Coleman, wife of the superintendent of the Atlanta cotton-factory, was another.

These accounts all appear the more credible from the fact that an examination proves every human being, and in fact every animal organism, to be in some degree a producing battery of electricity. Du Bois-Reymond, Nobili, and Matteucci have, by numerous experiments, determined the existence of electric currents in the nerves and muscles; by means of delicate tests, Becquerel has detected electricity in the capillaries and other minute tissues; Engelmann, Volkmann, Hermann, and others, have experimentally determined something of the conditions under which various tissue-currents are manifested; and it is more than probable that this subtile fluid is being constantly generated in the processes of digestion, circulation, respiration, and secretion.

The electric fishes—the torpedo, the silurus, the gymnotus, and the ray—are the only animals, it is true, possessing a special apparatus for the production of electricity; yet the cell-structure and disks of their batteries have been developed from ordinary cells and tissues common to animal life. Other animals sometimes evince like powers. An acquaintance of the writer, some years ago, in California, came upon a splendid specimen of rattlesnake which he determined to capture. With a forked stick he succeeded in pinning his snakeship to the ground just as he had reached a hole. The snake seemed to be securely caught, but with a convulsive effort he not only entered the hole, but gave my friend an electric shock which he recalls as one of the strongest he ever received.

We are largely ignorant of the conditions necessary to the storage of this force in the human organism, but good health seems to be one. When their power is dissipated by repeated shocks, electric fish exhibit all the lassitude of weary human beings. The writer once handled a gymnotus, in Fulton Market, whose shock was hardly perceptible; yet, when vigorous, they are known to kill horses and mules by their powerful discharges.

It is said that any person in good health may convert his lower extremities into electric batteries, by wearing two pairs of silk stockings, preferably a black pair over white. After wearing them but a short time and removing them together, an attempt to separate the two colors will manifest a resistance of several pounds.

Atmospheric conditions have much to do with electricity in the body. In several cases, notably those of Angélique Cottin

and Mrs. B—, of New Hampshire, this power was first discovered during the imminence of a thunder-storm. Human electrometers are sometimes met with. A young man named William Chapman, of Providence, R. I., was stunned by the shock of a stroke of lightning which struck his father's house. The current passed through his body and went out at his right heel, which was painful for some time afterward. On every occasion of a thunder-storm since then he feels, hours before the time, a tingling pain in the heel. Young Chapman would be a valuable acquisition to the Signal Service as a portable electrometer, and, if he can do as well as he is said to have done on certain occasions, he would be ahead of any device that science has yet lighted upon to foretell an electrical storm.

A remarkable instance of the salutary effects of atmospheric electricity on the human body is told by the Wolverhampton correspondent of the London "Times." He states that during a thunder-storm a collier named Bates, who had lost his sight through an accident, was being led home, when a flash of lightning was reflected on the spectacles he was wearing to conceal his disfigurement. After the peal of thunder which followed he complained of pain in his head. The next moment, to his surprise, he found that he had regained possession of his eye-sight. The occurrence caused considerable excitement in the locality.

Since the date of Galvani's discovery, there have been many persons sufficiently bold to assert the identity of electricity and life. Even before that period, the observance of electric phenomena in man had been a subject of popular interest. In his "History of Electricity," Priestley relates that drawing a spark from a living body "makes a principal part of the diversion of gentlemen and ladies who come to see experiments in electricity." Doubtless the diversion was not lessened by the fact that the "electrical kiss" was a favorite form of the experiment.

The excitement in Paris, Edinburgh, and other cities, following the application of galvanic electricity to dead bodies, was of a very startling character, many supposing that the secrets of life were about to be yielded up by this wonderful *fluid*. Bonaparte, it is said, after witnessing experiments in voltaic electrolysis, remarked to his physician, Corvisart: "Here, doctor, is the image of life; the vertebral column is the pile, the liver is the negative, the bladder the positive pole." Though much has been discovered since that statement was made, but a modicum of the truth probably is known.

Perhaps the developed man of the future, in his physiological relations to the universe, may exemplify the magnet, whose forces are exerted constantly as received without seeming detriment to its substance.

RESPONSIBILITY IN MENTAL DISEASE.*

By Sir JAMES CRICHTON-BROWNE, M. D.

I CAN not pretend to summarize what has been written or said about insanity and crime during the last forty years, or a fourth of that time. All that I propose is to submit a few observations which have occurred to me on the following points: (1) on the insufficiency of the definition or test of insanity at present accepted and acted on in courts of law in this country, and on an amended test which would commend itself to medical experience; (2) on the value of expert testimony in establishing the existence and nature of insanity in courts of law; and (3) on a practical step toward the reconcilement of medical and legal differences of opinion on questions of insanity and crime.

What is the law of England with reference to insanity as an excuse for crime, and how far is that law reasonable and in accord with the conclusions of medical science? As to what the law is, there can not be much doubt, for every judgment delivered in cases in which the plea of insanity has been set up since 1843 has been founded on the answers then returned by the judges to the questions put to them by the House of Lords during the groundswell of the McNaghten case. The gist of these answers runs: "That to establish a defense on the ground of insanity, it must be clearly proved that at the time of committing the act the accused was laboring under such a defect of reason from disease of the mind as not to know the nature and quality of the act he was doing, or if he did know it that he did not know he was doing what was wrong." Now, it is obvious that under this ruling, if I may call it so, are included a large number of cases of insanity. Under it would stand excused the raving maniac who does not apprehend the nature or quality of any act, the idiot who is in the same predicament, the fatuous person who can not foresee the consequences of his acts, and the victim of delusions, when these are of such a character as would justify homicide were they beliefs entertained by a sane man. But it is, and always has been, equally obvious to medical men that this ruling excludes a considerable proportion of cases of insanity in which moral as distinguished from legal irresponsibility exists, and that it is faulty in founding the test of insanity on knowledge or an intellectual state while it ignores states of the emotions and will, which are always more influential on conduct than intellectual states, and bulk far more largely in insanity. The test of insanity which

* Abridged from a lecture delivered to the College of State Medicine.

commends itself to medical men was never more clearly and succinctly expressed than by Lord Bramwell when in the Dove case he asked, "Could he help it?" Could he or she help it? That is the real practical question at issue in every case in which the defense of insanity is set up. Was the lunatic free to choose, or under the duress of disease? Was his will incapable or inept? But Lord Bramwell and those who think with him argue that it is sufficiently proved that the lunatic could help it if he knew the nature of his act—viz., that it was killing; the quality of his act—viz., that it was a crime; and also that it was wrong in the sense of being forbidden by law. Whereas medical men, almost without exception, maintain that a lunatic may be able to know and express the nature and quality of an act and its wrongness, and yet be as unable to resist doing it as he is to abstain from jumping under a smart electric shock; and that knowledge of the nature and quality of an act and its wrongness is not in the regions of pathology any measure of will-power. And not only medical men, but judges, have perceived this. The late Lord Chief-Justice Cockburn said, "The power of self-control, when destroyed or suspended by mental disease, becomes, I think, an essential element in the question of responsibility." And Mr. Justice Stephen has said, "It ought to be the law of England that no act is a crime if the person who does it is at the time when it is done prevented by defective mental power, or by any disease affecting his mind, from controlling his own conduct, unless the absence of the power of self-control has been produced by his own default." This statement of the law, which has been verbally amended by Dr. Bucknill, really covers all that medical men have ever contended for, and, having received it from so high an authority, it is their duty to do their best to secure its acceptance, and provide trustworthy tests of loss of self-control.

Now, impairment of will, or loss of self-control, more or less pronounced, is, according to medical men, the first, last, and universal element in insanity, and ranges from a trifling reduction in the check-action which we exercise on the ordinary currents of thought and feeling down to paralysis of the sphincters. Dissolution—and insanity is dissolution—implies a reversal of evolution, and in insanity we have, as Dr. Hughlings Jackson has taught us, a process of undevelopment, or taking to pieces, in the highest centers, which are the crown or climax of nervous evolution. In it we have "a descent from the least organized, most complex, and most voluntary, toward the most organized, most simple, and least voluntary." There is in every case of insanity impairment of voluntary control, and as a consequence of this there is more or less license given to those lower mental functions which are during sanity under voluntary control, and which become then overactive,

their overactivity being expressed in delusions, hallucinations, wild and whirling words, and extravagant actions.

When our attention is withdrawn—as, for instance, when we have dropped into a reverie or are just falling asleep—a sound that might have made us turn our heads, if on the alert, will cause us to start violently; and when in insanity volition is impaired, sensations that would have been almost unnoticed in health stir up morbid feelings. Did time permit, I think I could establish that affinitive sights, sounds, smells, tastes, and surface impressions, as well as organic sensations, play a larger part than is generally supposed in the induction of morbid impulses when the regulating brain-centers are weakened. Many sane persons have experienced horrid promptings when standing looking over a precipice or gazing at a passing train, and among the insane the glitter of a knife or the crackling of a fire will sometimes evoke suicidal or homicidal impulses which but for it might have remained dormant.

Will is the link between feeling and action, and when it is impaired it ceases to be available to prevent the transmutation of the energy of feeling into the energy of motion. And here we have an explanation of the utter inadequacy of the motives that constantly lead to insane crimes. There is no check-action; there is an abbreviation of that pause that gives time for foresight and reflection. "Must give us pause!" says Hamlet when on the brink of suicide—time to summon up the forces of rational resistance. Man is a hesitating animal. The whole system of Zoroaster hinges on the fact that everything noxious and evil in creation is the work of Ahriman, an independent power, whose wickedness depends on the fact that he acts before he thinks; whereas Ormuzd, the good spirit, thinks before he acts. And madmen may in many instances be distinguished from sane men in the same way. The impulsive madman acts before he thinks; feeling is translated into action with reflex precipitancy, with an abbreviation of that time interval between stimulus and response which can now be subjected to experimental measurement; in the absence, therefore, of all restraining considerations, and in a violent and disproportionate manner. I have known an epileptic to kill his attendant, beating his head into jelly, because he had prevented him from taking his daily walk. I have known another epileptic hang himself because a smaller portion of bread and butter had been served out to him than to his companions; and, in the recent case at Weston-super-Mare, the lad Hitchins shot his sister because of some trifling slight which she had put upon him. In all such cases a momentary irritation, a natural feeling of chagrin, such as we all feel when thwarted or disparaged, instead of being inhibited in its nascent state when inhibition is most powerful, so that the reaction to it may be reduced by deliberation to rational proportions, is, by the

diminished resistance of the will and the consequent overaction of the lower centers, permitted to become fixed or to express itself in a grossly exaggerated manner.

That voluntary power is invariably impaired in insanity is not perhaps evident to those who have not looked closely into the matter. Is it not true, it may be asked, that some insane persons exhibit extraordinary fixity of purpose and persist in some course of conduct—as, for example, the refusal of food with dogged obstinacy? That is so, but insane obstinacy is no more an indication of voluntary power than is the late rigidity of a paralyzed arm. That state of late rigidity in which the arm could not be stretched without being broken betokens that certain lower centers have been cut off from intercourse with higher ones and are undergoing degeneration; and so the unreasonable obstinacy of lunatics in insane conduct merely indicates that certain mental functions have escaped the regulation of volition, which is enfeebled, and are acting in an irregular and self-willed manner in consequence.

No doubt in all cases of insanity a certain amount of volitional power is retained, and this may in certain cases be effectual to some extent over the morbid mental manifestations. There may be contributory negligence on the part of a lunatic, just as there may be on the part of an invalid. Prof. Rühle, of Bonn, recommends the birch-rod and shower-baths in certain cases of chronic vomiting, and asserts that children often die of a bad bringing up, and adults because they can not, when ill, make up their minds to do what is right and omit what is hurtful; and Niemeyer quotes with approval the dictum of the wife of a Prussian general, a most determined woman but a tender mother, that whooping-cough is only curable by the rod. But no one in this country would now sanction such heroic treatment, or believe that anything but evil could come from such stringent appeals to a mere remnant of will in its corporeal relations; and so it would be dangerous in cases of insanity, in which will is obviously and seriously involved in its mental relations, to infer that what survives of it might, if put forth, have prevented a criminal act. In insanity, in which the mental movements are typically involuntary, but yet susceptible of some control, we must not expect of the patient what is beyond his strength—the habitual suppression of his morbid impulses. The criminal act of a lunatic is sometimes so alien to his healthy disposition, or so clearly motiveless, that we have no hesitation in concluding that his true will must have been in abeyance when he fell into it. At other times it follows upon mental struggles which he has himself described, and asked help in, previous to its commission, and is therefore clearly but the climax of a pathological process signifying the overthrow of the will. And at other times, again, it is associated with mental

and bodily symptoms which, our experience has taught us, correspond with complete paralysis of will.

A lunatic may unquestionably commit a crime under ordinary motives. It can not be contended that every mental oddity and isolated delusion is to put a man beyond the pale of the law, but it is to be remembered that a really isolated delusion is a rarity, and that most delusions are but local manifestations of a constitutional vice, involving weakening of will. Most lunatics are, it has been said, mad to their finger-tips; and what appear to be their sane acts are generally more or less tinctured with insanity.

I can not pause here even to sketch the several stages of mental dissolution, but I would suggest that there are practically three levels of these in connection with lunatic crime. They are—the ideational level, the impulsive level, and the automatic level. On the first, the ideational level, the criminal act is committed under the influence of an insane motive or a delusion or hallucination, with consciousness at the time and remembrance afterward of all that has taken place, but in consequence of a diminution of inhibitory or resisting power. On the second, it is committed under the stress of a sudden and irresistible impulse, which is often a reversion to a mere animal instinct, with vague or imperfect consciousness at the time, obscure remembrance afterward, and under a still more grave paresis of inhibitory power. On the third, it is committed under the influence of accidental or reflex suggestion, without consciousness at the time or remembrance afterward, and during the complete abrogation of inhibitory power. As illustrations, I may mention on the first level the case of a man who kills his friend with elaborate preparation to spare him suffering, because he has been told by the archangel Michael that the death of that friend is necessary to the extinction of Freemasonry, which is the curse of the human race, and who afterward describes the homicide in detail, and with evident pride and satisfaction; on the second level, the case of a puerperal woman, who, seeing a glittering knife by her bedside, suddenly cuts her baby's throat, without afterward having any clear recollection of the event or being able to say why she did it, although the knowledge that she had done it fills her with grief and remorse; and on the third level, the case of an epileptic, who, while recovering from a fit, kills whoever happens to be nearest to him, while still unconscious, and who retains afterward no trace of recollection of the tragedy.

It seems to me that nothing has more retarded an approach to a just appreciation of the relations of responsibility and disease than the assent, tacit or explicit, generally given to the dogma that the existence of insanity is a question for men of common sense—a question which they are quite as capable of deciding as medical men or experts. The late Lord Shaftesbury, who, by his

philanthropic labors, conferred such signal benefits on the insane, did some disservice to medical jurisprudence when he lent the weight of his authority to this doctrine, and maintained that "persons of common sense, conversant with the world, and having a practical knowledge of mankind, brought into the presence of a lunatic, would in a short time find out whether he was or was not capable of managing his own affairs"; and the late Sir Benjamin Brodie erred, I think, still more grievously when he said: "It is a great mistake to suppose that this is a question (unsoundness of mind) which can be determined only by medical practitioners. Any one of common sense, and having a fair knowledge of human nature, who will give it due consideration, is competent to form an opinion on it; and it belongs fully as much to those whose office it is to administer the law as it does to the medical profession."

Now, it may be admitted that there was a time when medical science was in its infancy, when the functions of the brain were unknown, and when only metaphysical explanations of insanity were attempted, at which the existence of insanity in any given case might have been as correctly determined by plain, unsophisticated men as by pretentious empirics. Further, it may be granted that there are an immense number of cases of insanity in which the symptoms of the disease are so obvious and external, that special skill, although requisite to interpret these symptoms, explain their causes, predict their results, and prescribe treatment, is not necessary to their identification. But, beyond all this, there are, it must be maintained, cases of insanity of so obscure and subtle a nature that they can only be properly identified by those who have made themselves intimately acquainted with the functions of the nervous system in health and disease, and who have by experience come to appreciate the significance of combinations of mental phenomena and of concomitant bodily variations, which would appear meaningless to the uninitiated.

The fact is, that practically the utility of expert testimony in insanity is acknowledged, and it is difficult to understand how it could be otherwise, for all who have made only a superficial study of mental diseases must perceive that there are in them little signs and symptoms, perversions of thought and derangements of bodily functions, which would altogether escape the notice of common sense, but warrant an expert, founding on his experience, in proclaiming that the will is reduced to impotency, and that the lunatic can not control himself. There is something in the appearance, manner, and mode of expression of lunatics of various classes which would pass unnoticed by common sense, but be characteristic to those who had been accustomed to watch them narrowly. There are styles of morbid thought which can not be

simulated. There are latent or concealed delusions which start into view when the appropriate spring is touched. There is the order in disorder of dissolution which can not be imitated. There are types of delusions and hallucinations which are easily recognized. And, above all, there are physical signs of disorder of the brain and nervous system which correspond with certain stages in the degradation of will-power.

To the expert witness in cases of insanity and crime these questions should, it seems to me, be put: Was the prisoner insane at the time when he committed the act of which he is accused? Was his insanity of such a nature and degree as to deprive him of control over his conduct? What are the grounds upon which you have formed these opinions? It would then remain for the jury, aided by the judge, and with the assistance of other experts if necessary, to decide on the validity of the grounds stated and on the weight to be attached to the opinions expressed.

Expert testimony, to be of the highest value, ought of course to be founded on an examination, or, better still, on repeated examinations, of the accused, made as soon as possible after the perpetration of the crime. But insanity is a chronic disease; and even when the expert has not seen the alleged lunatic until some time after his crime, he may still be able to say whether in the course of a disease still existing, or of the recent existence of which there are traces, such a criminal act was likely to crop up as part and parcel of the disease; and whether it is consistent with his experience and with the history of the act that the accused could not help it. When the crime was committed during a temporary paroxysm of madness or during an attack from which recovery has taken place before the examination has been ordered, it may still be possible for an expert to say whether the symptoms described to him form a true picture of mental disease or are only a spurious copy, and whether any wreckage still marks the course of a nerve-storm. Sometimes it will be impossible for an expert to make up his mind either one way or the other, and then it is his duty plainly to say so.

And now I have a practical suggestion to offer which would, if adopted, I venture to believe, do more to reconcile the great professions of law and medicine on the questions at issue between them respecting insanity and crime than any prolongation of those elaborate and sometimes highly spiced logomachies in which they have both indulged in the past.

What is wanted is a series of skilled and sustained observations on homicides who have escaped punishment on the plea of insanity, made by competent and unbiased authorities, couched in language understanded of the people, and published from time to time. And, in order that such a series of observations may be

pursued, I would propose the appointment of a committee or commission, composed in equal parts of lawyers and medical men, whose duty it should be to visit the asylums as often as they might deem expedient, to examine individually all patients detained there who have been charged with murder, and also the officers of the asylums, and their case-books and registers, and to report annually on the mental condition of every such patient, with special reference to the circumstances of the crime of which he or she was accused, and the evidence adduced at his or her trial, adding such remarks on the relations of insanity and crime, and such recommendations for alterations of the law, as their experience may suggest to them.

Looking forward to such reports, the faithful scientific witness would speak with confidence, assured that his evidence, although it might appear strained at the time, would be confirmed by events; while the pseudo-scientific witness, if there be any such, who is led into the box by a thirst for notoriety or a spurious philanthropy, would pause before committing himself to statements which might rise up in judgment against him in a very damaging and persistent way. And there can be no impropriety in alleging that such reports would ultimately prove useful to judges and counsel.

Beyond this, the deliberations of such a commission would conduce in some degree to an agreement between lawyers and doctors on the question of insanity and crime. It is in the atmosphere of the courts of law that differences between them spring up, differences which in private conference speedily dwindle away. It is about theoretical definitions and verbal distinctions that they contend; and wherever they are brought together in actual contact over a case anywhere save in a court of law, the lawyers with striking aptitude adopt the scientific standpoint, and harmony results.—*The Lancet.*

THE LUCAYAN INDIANS.

By Prof. W. K. BROOKS,
of Johns Hopkins University.

IN three years the world will unite in celebrating the four hundredth anniversary of what, from our point of view, is the grandest and most important event in history, the landing of Columbus; but in our consciousness of its profound significance, are we not in danger of forgetting that the Spaniards *discovered* America in the way that pirates discover a vessel with a helpless crew?

While no one can doubt that the world, as a whole, has been benefited, there is reason to question whether any of the islands which Columbus himself discovered have profited by the change.

Hayti is almost completely in a state of revolting and hopeless savagery, and recent writers assert that Jamaica is rapidly traveling the same road. The condition of Cuba is by no means encouraging to her friends; and in the Bahamas, abandoned homesteads, costly villas tumbling to ruins, roofless walls, and fields and plantations converted into tropical jungles, testify to anything but prosperity. The population of the Bahamas is less to-day than it was on the day Columbus landed, and it is not increasing.

He found the Bahamas in the possession of a prosperous and happy people who called the islands the Lucayas, and themselves Ceboynas. Twelve years afterward every soul of this population of more than forty thousand men, women, and children had perished in a strange land under the lash of the slave-driver; the race was blotted off the face of the earth, and the only impression which has been left upon our civilization by those who first welcomed it to this continent is a single word, which, together with the luxurious article it designates, has spread over the whole earth. The Ceboynas gave us the hammock, and this one Lucayan word is their only monument.

Nowhere in all the black pages of history is there a darker tragedy than theirs; and while it is eminently proper that we should pay all homage to the transcendent genius and noble nature of the great admiral, and that we should celebrate with all pomp and pride the miraculous growth of our own civilization, does it not also become us to commemorate in some way, at the same time, the story of the unhappy and forgotten Ceboynas, to whom the discovery had a still more profound significance?

How intensely interesting, just at present, is any addition to our knowledge of the other party to the transaction! The writer has recently spent two seasons in zoölogical research in the Bahama Islands, and has been able to learn a few facts, which are new to the science of anthropology, relating to the bodily structure of the long-lost Ceboynas, and thus to contribute toward the perpetuation of their memory.

There is not much intrinsic interest in a few fragments of human bones, but the Ceboyna skull which stands upon my table as I write gives life and vivid reality to the familiar story in the first chapter of my school history, and calls up in all its details with startling clearness the drama of the Bahama Islands.

To most of us these islands are little more than dots upon the map, but, small and sterile and unimportant as they are, they form one of the fairest landscapes upon earth, for they present all the conditions which are most favorable for intensity of color of earth and sea and sky. Under the combined influence of white soil, intense sunlight, and perfect purity of air and water, they

glow with the sparkling colors of jewels. The hot air is loaded with moisture to the saturation-point, like that of the deep, shady recesses of a rocky glen on the edge of a waterfall; but the islands are also as wind-swept as a mountain-top, and the air is absolutely pure, for the ocean breeze brings with it no smoke nor dust, no pollen nor vegetable refuse, nor anything whatever except pure, moist, warm air. As the saturated sea-breeze blows over the thousand islands of the archipelago, the slight difference between the temperature of the changeless ocean and that of the variable land, which heats quickly in the daytime and cools quickly at night, manifests itself by the formation of great, snow-white banks of summer clouds which are as characteristic of the Bahama horizon as the water itself or the deep, pure blue of the sky between the clouds.

The islands stand on the extreme edge of a submerged abyss where the surface falls as suddenly and to as great a depth as it does from the summit of the Andes, and the unfathomable water of mid-ocean is only a few miles away. Some of the out islands are only two miles or so from water more than two miles deep, and the currents which sweep through the sounds and around the islands at each turn of the tide are absolutely pure, and they have the intense color which is found in mid-ocean, or the melted ice of glacial lakes, or in the center of the rocky basin of Lake Superior. In great depths this color is a pure, vivid sapphire blue, darker but more transparent than the blue of the sky. In the shallow sounds, where the intense sunlight is reflected back from the chalky bottom, it glows like a surface of beryl with an intense green lustre totally unlike anything which is met with in other waters, although the center of the Horseshoe at Niagara would be very similar if it plunged over a ledge of white marble under the light of a tropical sun. All these influences combine to give a degree of intensity and vividness which can not exist in a continent to all the colors of a landscape which is wrapped in perpetual spring. Under their dome of blue sky and snowy clouds the Isles of June, in their setting of sapphire, are buried under a mantle of verdure so dense and luxuriant that the vegetation thrives as if in a hot-house, and, abandoning the rocky and sterile ground and contenting themselves with the warm, moist sea-breeze, not only the mosses and ferns and orchids and bromeliads, but large trees as well, grow tier above tier, climbing over each other's heads in their efforts to escape the struggle for existence and to obtain air and sunlight and standing-room.

Who can wonder that, when Columbus found himself in this enchanted fairy-land after the changeless monotony of mid-ocean and all the anxieties of his long voyage into unknown waters, he

should have been most profoundly impressed by its beauty, for nowhere on earth can we find a fairer land than these Isles of June. The exciting occupations incident upon his arrival left him little time for writing, but he faithfully jotted down day by day in his log-book in short, crisp sentences which even now are full of graphic interest, the impressions which were still fresh upon him. The United States Coast Survey has recently done good service to history by the publication of an English translation of this rare and almost unknown document, and the extracts in this paper are from this translation. After he set sail on the second day, he says that he saw so many islands that he could not decide to which one he should go first, and the men he had taken told him by signs that they were innumerable. On the fifth day he writes of the island which he named Isabella: "There was in it twelve leagues, as far as a cape which I called Cape Beautiful, which is in the west, and so it is beautiful, round, and very deep and free from shoals; at first it is rocky and low, but farther in it is a sandy beach, as it is along most of our coast. The island is the most beautiful thing I have seen; if the others are very beautiful, this is still more so; it has many trees, very green and very large, and this land is higher than that of the other islands I have discovered, although it can not be called mountainous. Yet gentle hills enhance with their contrasts the beauty of the plain, and there appears to be much water in the middle of the island. Northeast of this cape there is an extensive promontory, and there are many groves very thick and very large. I wished to anchor off it in order to land, and visit so handsome a spot, but it was shallow and I could not anchor, except far from land, and the wind was very favorable to come to this cape, where I am now anchored, and which I have called the Cape Beautiful because it is so; and so I did not anchor off that promontory, because I saw this cape so green and so beautiful, as are all the other things and lands of these islands, so that I do not know to which to go first, nor do my eyes grow tired with looking at such beautiful verdure; and when I reached this cape the odor came so good and sweet from flowers or trees on the land, that it was the sweetest thing in the world."

Of the Island of Fernandina, he says (October 16th): "The island is very green and level, and exceedingly fertile. . . . I saw many trees whose shape was very different from ours, and many of them which had branches of many kinds, although all growing from one trunk, and one branch of one kind and another of another kind, and so different that the diversity of the kinds is the greatest wonder of the world—for instance, one branch had leaves like those of cane, and another like those of a mastic; and thus on a single tree there were five or six of these kinds, and all

so different; nor can it be said that they have been grafted, because these trees grow wild in the field and nobody cares for them.

"The fishes here are so different from ours that it is a wonder. Some look like cocks of the finest colors in the world, blue, yellow, red, and all colors, and others variegated in a thousand fashions; their different hues being so exquisite that nobody can contemplate them without wondering, and feeling great delight in seeing them. There are also whales here; but on shore I saw no beasts whatever, save parrots and lizards."

Columbus found all these islands much more thickly inhabited than they are to-day, by a race of people who called themselves Ceboynas, although his misconception as to the nature of his discovery led him to bestow on them the name by which all the aboriginal inhabitants of this continent are now known.

As they had very few artificial wants, and were able to live without forethought or care in a land which knows no change of seasons, where the harvest ripens without attention, and a tempting fish for the day's dinner can be picked out and speared as if it floated in the clear water of an aquarium, they were totally ignorant of much that the Spaniards regarded as essential for man, and Columbus, mistaking simplicity for destitution, makes the entry in his log-book that he "thought them to be a very poor people." It is true that, except for the "one who wore in his nose a piece of gold of the size of half a castellano, on which were letters," he found no indications of the wealth of India; but before he had been a week in the New World he discovered three luxuries which have been warmly welcomed by the whole civilized world.

On the third day he enters in his log that "the men I sent for water told me that the houses were well swept and perfectly clean, and that their beds and coverings looked like cotton nets, which they called *hamacas*"; and within a few days, as he extended his explorations to the neighboring Antilles, he met with cigars and chocolate. Poor the Ceboynas might be in the matter of useless clothing and arms, but a race which could doze idly in hammocks, under the blue sky, in the warm sea-breeze, idly puffing their Havana cigars, as they gazed out on to the flashing water and waited for their crops to ripen, were not completely destitute and squalid. Civilized man might well covet even a harder life than that of the natives of the lovely Lucayan Islands before the discovery, but every school-boy knows the rude awakening which the peaceful Ceboynas soon received.

Two years ago I enjoyed the delights of a long cruise, in the schooner which carries the mails, through the calm, landlocked sounds which thread in all directions the mazes of the archipelago, and the gentle but unfailing breeze bore me on day after day,

while new beauties rose up and unfolded themselves before me as the islands I had passed dropped down toward the horizon behind me and faded away, until there stole over me the feeling that the whole might be some fairy landscape traced by fancy in the summer clouds, and that if I closed my eyes for a minute I might find it all dissolving into air.

As I passed the little inlets, with their lines of white breakers, and beyond them the deep blue of the open ocean fading in the distance into the lighter blue of the sky; or, as I leaned over the rail while the vessel slipped on as if it were hung in mid-air; as I watched the gaudy fishes darting over the white sand many fathoms below, or caught glimpses into the deep dark caves between the great, dome-like coral-heads which swept up in smooth curves from the depths almost to the surface, and overhung cool grottoes hung with gorgeous anemones and sea-fans and sea-feathers, among which innumerable animals in an endless diversity of strange forms could be dimly seen as the vessel slipped by; as I drifted on day after day, and passed one charming spot after another, only to find still more beauty beyond, I could not escape the thought that in this enchanted land of beauty which no brush could paint, where every prospect pleases, man has been unutterably vile, and this not the heathen in his blindness, but the conqueror who, as old Bernal Diaz quaintly but frankly puts it, "Took his life in his hand that he might give light to them who sit in darkness, and satisfy the thirst for gold which all men feel."

Less than fifteen years after the discovery the forty thousand Ceboynas were gone, and the Lucayas were left desolate. For nearly two hundred years every one of these thousands of lovely islands was abandoned to the parrots and lizards, and, except for the visits of Ponce de Leon, in his search for the magic fountain, and an occasional English sailor, no boat moved through these quiet sounds; until at last the peaceful islanders who, as Columbus writes to Queen Isabella, were the best people on earth, and loved their neighbors as themselves, were replaced by a new population, and the banner of the Jolly Rodger gathered here, from the ports of Europe, the worst human scum which civilization has ever produced. Who could cruise through this earthly paradise without meditating upon the fruit of our civilization as it has here developed itself?

While Columbus had none of the vices of lesser men, he felt bound to fulfill his promise to enrich those who had aided him; and on his first Sunday, October 14th, only two days after his landing, the gentle influences of the Sabbath in this strange and beautiful land moved him to commit his impressions to writing, and, while his pen overflows with the delights of the New World and the loveliness of the people, he enters in his log that he is

keeping a keen watch for a place to build a fort; for, he says, "Inasmuch as the people are perfectly defenseless, and totally unacquainted with arms, a force of fifty men could keep them captive in their own island and make them do whatever might be desired," in case the king might not wish them all taken to Spain as slaves.

As he found no gold, except the nose-ornament, worth about a dollar and a half, which the owner refused to barter for glass beads, Columbus soon left the Lucayas, and for a few years they were forgotten. By an accident hardly less probable than the discovery of a new world, he soon actually found rich gold-mines in Hayti, and for a time the Spaniards forgot their desire to give light to them who sit in darkness, in their eagerness to slake their thirst for gold. They did not, however, forget the cotton nets of the Ceboynas, and they soon discovered, as all white men in the tropics do, that it is much easier to lie in a hammock puffing a cigar, and to sip chocolate as the days slip by, than to dig for gold, and they then bethought themselves of their duty to enlighten the darkness of the heathen natives of the Lucayas.

The king at once perceived the importance of bringing these people under Christian influences, and in 1509, or less than eleven years after the discovery, he issued an order for the deportation of the whole population of the Lucayas to New Spain, and the work of conversion was at once vigorously instituted with the aid of blood-hounds.

For a time the Spaniards seem to have regarded the Antilles as an inexhaustible slave-quarry, and to have thought it cheaper to replenish their exhausted stock of slaves than to care for those they had. They soon found, however, that it was not so easy as Columbus had thought to make the Ceboynas "do whatever might be desired"; and while the people who had never labored for themselves were powerless to escape slavery, they resisted to the death all the efforts of the Spaniards to profit by their labor.

So relentless were the conquerors, and so determined and hopeless the captives, that the unhappy slaves perished by wholesale in the mines of Hayti, under the lashes of their drivers and the steel swords which were often broken over their obstinate heads; and even now the mind recoils from the contemplation of the few facts regarding the fate of the Lucayans which history has preserved.

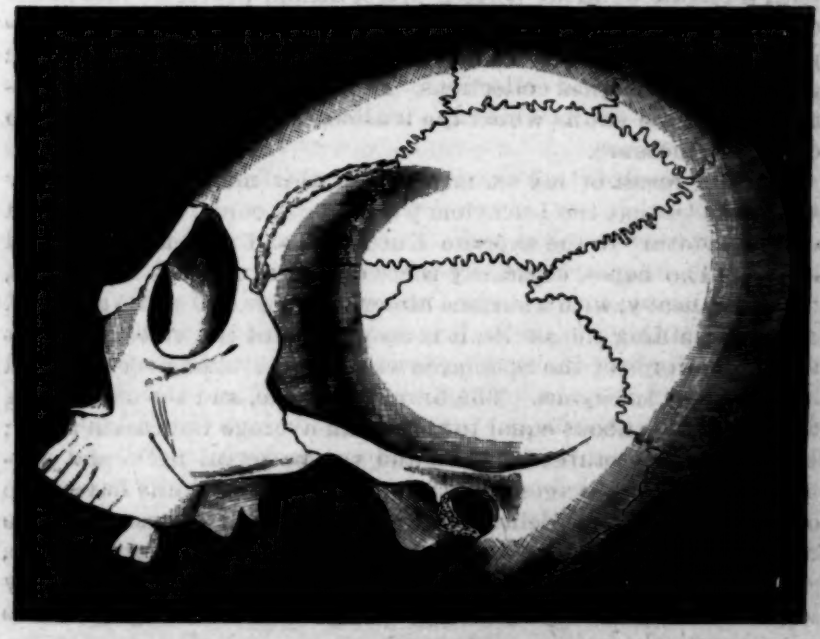
As an illustration, Las Casas gives, among others, the case of one Spaniard who, three months after he had received three hundred Lucayan slaves, had less than thirty left alive. For a short time this destruction was made good by fresh importations, but the supply was soon exhausted. All the islands were left deso-

late, and the Lucayan race was as if it had never been. The hammock, the first gift of the New World to civilization, is their only monument, and the word the sole remnant of their language.

Columbus says that, on Saturday, October 13th, the second day, "A great crowd came, each bringing something, giving thanks to God, and entreating or beseeching us to land. We understood that they asked us if we had come down from heaven"; and before the children, who were led to the beach to welcome the celestial visitors who had been borne to them on white wings out of the blue dome which bounded their world, had grown to manhood, they perished, with all their race, in a foreign land.

Where shall we find a sadder story than this? The evil was done long ago; there is now no remedy; but as the recollection thrills our pulse, and our generous sympathies are awakened, how eagerly do we ask the question: "What manner of men were the Lucayans? What were they like?"

These questions I am now able to answer, at least imperfectly,



and the skull which is here figured once belonged to a person who may possibly have been among those who welcomed Columbus.

Like all coral islands, the Bahamas abound in caves, and these were used in some way by the Ceboynas, perhaps as burial-places, possibly as refuges from the blood-hounds of the Spaniards. The floor of these caves consists of red clay, rich in phosphates and of commercial value, and within recent years it has been removed

from most of them and sold. During the excavations many human bones and other relics were found, but they attracted little interest, and most of them were destroyed. I learned, however, during a recent visit to the islands, that a few of the bones had found their way into the hands of thoughtful and intelligent persons, and had thus been preserved. Their custodians at once appreciated my desire to study them, and generously placed them at my service for this purpose, so that I was able to obtain notes for a pretty complete anthropological description of the Ceboynas. The wife of the governor of the colony, Mrs. Blake, a most enthusiastic and able naturalist, whose contributions to science are well known, had herself explored one of the caves—an undertaking which calls for energy and endurance quite incomprehensible to any one who has never attempted exploration in the tropics. She had found fragments of several skeletons in the cave, and she placed them all in my hands as soon as I expressed a wish to study them. Dr. J. C. Alberry, a Nassau physician, was equally generous with a female skull in perfect preservation, which he had in his office, and both he and Mrs. Blake afterward authorized me to deposit these relics of a lost and almost unknown race in one of our great anthropological collections. The Nassau Public Library contains two male skulls which the trustees kindly permitted me to draw and measure.

As the result of my examination of this material, I am now able to state that the Lucayans were large people, about equal in size and stature to the average European, and very muscular and heavy. The bones, especially those of the skulls, are very thick, firm, and heavy, with a surface almost as dense and white as ivory. After examining the skulls, it is easy to credit the statement that the steel swords of the Spaniards were often broken over the hard heads of the Lucayans. The brain was large, and the capacity of the cranium is about equal to that of an average Caucasian skull; but they had protuberant jaws and the powerful neck- and jaw-muscles of true savages, and the outlines of the skulls have none of the softness and delicacy which characterize those of more civilized and gentle races of men. The eyes were very oblique, sloping downward away from the nose, and the orbits are very large and angular. The cheek-bones are broad and high, and the jaws peculiarly massive and square.

The skulls are extremely broad in proportion to their length, and they are among the most brachycephalic, or round-headed, of all known human skulls, the greatest breadth being more than nine tenths of the greatest length.

The Ceboynas flattened their heads artificially in infancy, so that the vertical part of the forehead is completely obliterated in all the adult skulls, and the head slopes backward immediately

above the eyes. This flattening was practiced to such a degree that the bones of the child's skull were often broken by the pressure of the bandages, and two out of the four skulls had false joints, which appear to be the result of fracture produced in this way.

The type of the race is extremely well marked, and, after one of the skulls had been examined, it was easy to see at a glance that the others belong to the same people, and their characteristics agree closely with the very short description of the Ceboynas which Columbus gives.

In his log-book, October 13th, he says: "At dawn many of these men came down to the shore. All are, as already said, youths of good size and very handsome; their hair not woolly, but loose and coarse like horses' hair. They *have broader heads and foreheads than I have ever seen* in any race of men, and the eyes very beautiful, not small. None of them are black, but of the complexion of the inhabitants of the Canaries. All, without exception, have very straight limbs, and no bellies, and very well formed."

This passage, and a few others in his log-book, contain nearly all that is known of the race, for the rapidity with which discovery followed discovery was unparalleled; and the simple Lucayans attracted little interest or attention after the Spaniards found the large fertile islands of the Antilles and the civilization of Mexico.

We know, however, that the statements in the histories to the effect that they were naked, weaponless, and without arts, are incorrect, as they are based upon the impressions which Columbus formed during his first day among them.

It is true that the men who welcomed Columbus were naked and without weapons, and that, as they sat in their canoes, with their stiff, black hair cut straight across their low foreheads and hanging down behind in a long scalp-lock, with their naked bodies painted, "some black and some white and some red, and some whatever they find," they must have seemed like thorough savages. He soon found, however, that they had gardens and neat, well-swept houses, and that they knew how to manufacture cotton cloth, and had such simple clothing as suits the climate. Their large canoes, hewed out of the trunks of single trees, were large enough to hold forty or fifty men each, and "wonderfully built according to the locality," and Columbus says they were skillful boatmen, paddling with wonderful speed, and managing them with great dexterity.

Fragments of pottery, household utensils of carved wood, and rude pictorial carvings have been found in the islands, and the occasional discovery of beautifully polished stone implements proves, like the piece of gold marked with letters, that they were

in communication with distant lands, for there is no rock, except soft coral limestone, anywhere in the archipelago. They knew the direction and distance of Cuba and Hayti, and they called the larger island by the name which it still bears. Their language was almost identical with that spoken in these islands, and, while they were upon the extreme edge of the civilization of the Gulf of Mexico, they were not entirely outside its influence, and the discoverers were able to use them as interpreters as far away from their home as Campeachy.

This is about the sum total of our knowledge of the Cebaynas, and does not their share in the discovery entitle them to our remembrance, and bind us to do what we can before November 12, 1892, to preserve them from complete oblivion?

What can we do to perpetuate their memory? There is one thing which would be a most worthy and becoming testimonial if it were practicable. The injury which they have sustained is past and irreparable, but if three years hence we could celebrate the institution of a wise, humane, and consistent method of dealing with the wards of our nation in place of the one which was initiated when Columbus devoted his first Sunday to a search for a fort, the shades of the Ceboynas might accept the sacrifice.

What else is there to be done? Can we not restore to the map the pretty word "Lucayas" as the name for the islands? Surely if Columbus has Columbia for his monument, the Lucayans are entitled to the Lucayas; and while this is only a little thing, it would be a graceful tribute to them.

In the little-known interior of the larger islands there are many caves which have never been disturbed. Canoes, stone implements, carved utensils, and other articles have been found from time to time in the out-islands, and, while the articles have no great archæological interest, the part played by their owners in the events which are so soon to be commemorated would give great value to any new discoveries.

The delightful climate and the beauty of the landlocked sounds give to the Bahamas the greatest charm as a cruising-ground; and if some yacht-owner were to devote himself to exploration, with a well-equipped and energetic staff of earnest assistants, he might hope to gather a collection of Ceboyna relics which, placed in one of our museums, would be a permanent monument to their memory.

DR. EDUARD NAUMANN, of Munich, has advanced the theory, in a British Association paper, that the magnetic curves of the earth, wherever a magnetic survey has been made, show a distinct relation to mountain ranges, faults, eruptions, and tectonic disturbances. He urges that the investigation of this subject be taken up at once all over the world.

SPEECH AND SONG.

By Sir MORELL MACKENZIE.

PART I.—SPEECH.

IN dealing with the two great forms of local utterance, it will be most convenient to take them in their historical, or at any rate their logical, order. Whatever "native wood-notes wild" our hypothetical half-human ancestor may have "warbled" by way of love-ditties before he taught himself to speak, there is no doubt that singing as an *art* is a later development than articulate speech, without which, indeed, song would be like a body without a soul. I will, therefore, treat of speech first; and it will clear the ground if I begin with a definition. Physiologically, speech is the power of modifying vocal sound by breaking it up into distinct elements, and molding it, if I may say so, into different forms. *Speech*, in this sense, is the universal faculty of which the various *languages* by means of which men hold converse with each other are the particular manifestations. Speech is the abstract genus, language the concrete species.

I am happy to say it does not fall within the scope of my present purpose to discuss the origin of language, a mysterious problem, on which the human brain has exercised itself so much and to so little purpose, that some years ago, I believe, the French Academy declined to receive any further communications on the subject. The origin of the *voice* is a different matter. The vocal function is primarily a means of expression. I see no reason for disagreeing with Darwin, when he says that "the primeval use and means of development of the voice" was as an instrument of sexual attraction. The progenitors of man, both male and female, are supposed to have made every effort to charm each other by vocal melody, or what they considered to be such, and by constant practice with that object the vocal organs became developed. Darwin seems inclined to believe that, as women have sweeter voices than men, they were the first to acquire musical powers in order to attract the other sex, by which I suppose he means that the feminine voice owes its greater sweetness to more persevering culture for purposes of flirtation. I do not know whether the ladies of the present day will own this soft impeachment, or whether they will be flattered by the suggestion that their remote ancestresses lived in a perpetual leap-year of courtship. Other emotions, however, besides the master passion of love had to be expressed; joy, anger, fear, and pain had all to find utterance, and the nervous centers excited by these various stimuli threw the whole muscular system into violent contractions, which in the

case of the muscles moving the chest and the vocal cords naturally produced sound—that is to say, voice. These movements, at first accidental and purposeless, in time became inseparably associated with the emotional state giving rise to them, so as to coincide with it, and thus serve as an index or expression thereof. From this to the voluntary emission of vocal sounds is an easy step, and it is probable enough that the character of those sounds was primarily due to the "imitation and modification of different natural sounds, the voices of other animals, and man's own instinctive cries." *

The mechanism of the voice is extremely simple in its general principles, though highly complex in its details. Fortunately, a knowledge of the latter is not required for the comprehension of the main facts relative to the production of the voice, and I shall not further allude to them here. Vocal sound is produced solely in the larynx, an elementary fact which must be thoroughly grasped, as many absurd notions are current even among people who should know better, such as that the voice may be produced at the back of the nose, in the stomach, and elsewhere. The larynx is a musical instrument of very complex structure, partaking both of the reed and the string type, the former, however, distinctly predominating. It is essentially a small chamber with cartilaginous walls, which is divided into an upper and a lower compartment by a sort of sliding floor, or double valve, formed by the two vocal cords. In breathing this valve opens, its two lateral halves gliding wide apart from each other, so as to allow a broad column of air to pass through; in speaking or singing, on the other hand, the valve is closed, but for a narrow rift along its middle. Through this small chink the air escaping from the lungs is forced out gradually in a thin stream, which is compressed, so to speak, between the edges of the cords, that form the opening technically called the "glottis," through which it passes. The arrangement is typical of the economical workmanship of Nature. The widest possible entrance is prepared for the air which is taken into the lungs, as the freest ventilation of their whole mucous surface is necessary. When the air has been fully utilized for that purpose, it is, if need be, put to a new use on its way out for the production of voice, and in that case it is carefully husbanded and allowed to escape in severely regulated measure, every particle of it being made to render its exact equivalent in force to work the vocal mill-wheel. When the air is driven from the lungs up the windpipe it strikes against the under surface of the floor or double valve formed by the vocal cords, which are firmly stretched to receive the shock, forces them apart to a greater or less extent, and, in rushing out between them, throws them into vibration.

* "Descent of Man," second edition, 1882, p. 87.

The vibration of the vocal cords makes the column of air itself vibrate, and the vibration is communicated to the air in the upper part of the throat, the nose, and mouth, from which finally it issues as *sound*. The vocal cords are the "reeds" of the vocal instrument, and as, owing to the extraordinary number and intricate arrangement of their muscular fibers, they can change their length and shape and thickness in an almost infinite variety of ways, they are equal in effect to many different reeds. If the vocal cords can not move so as to bring their edges almost into contact, or if there is any substance between them which prevents them from coming together, the voice is destroyed; if there is anything (such as a growth) in or on one of them, its vibration is more or less checked, and hoarseness is the consequence. The primary sound generated in the larynx is modified by the shape, size, and density of the parts through which the vibrating column of air has to pass before it issues from the "barrier of the teeth." These "resonators," include the part of the larynx above the vocal cords, with the little sounding-board, the epiglottis, covering it; the upper part of the throat or pharynx, the nasal passages with certain echoing caves in the bones of the skull which communicate therewith; and the mouth, with the soft palate and uvula, tongue, cheeks, teeth, and lips. It is to these resonators, as well as to the size and shape of the larynx itself—and those parts, like the features of the face, are never exactly similar in any two individuals—that the distinctive quality, or *timbre*, of the voice is due.

Timbre is the physiognomy of the voice by which the speaker can be recognized even when unseen. Just as the face may be lit up with joy, darkened with sorrow, or distorted with passion, so may the voice be altered by strong mental emotion. This is due to the influence of the mind on the nervous system, which controls every part of the body: if it be stimulated, increased action will be excited; if disordered by shock, feeble irregular movements will be produced, the limbs will shake, and the voice tremble. From the effect of peculiarities of physical conformation on the voice it will be readily understood that *timbre* may be, in some degree, a national or racial peculiarity. There are also certain physical types which correspond to particular *timbres* of the voice. I have noticed this particularly in persons of like complexion even when different in race. Thus, a certain sharp metallic clearness of articulation is often found in individuals of ruddy complexion, light yellow hair, and hard blue eyes, while rich, mellow tones, with a tendency to *portamento* in ordinary speech, are often associated with black hair and florid face. A remarkable point is that the same voice may be altogether different in *timbre* in singing from what it is in speaking. The difference is probably due to the fact that in singing the resonators are, instinctively, or as the

result of training, managed in a more artistically effective manner than in ordinary speech.

Speech differs from song as walking does from dancing; speech may be called the prose, song the poetry of vocal sound. Mr. Herbert Spencer has defined song as "emotional speech," but this term might with greater justice be used to designate the hystero-epileptic oratory which threatens to become acclimatized in this sober island, or even to the exchange of amenities between two angry cabmen. It would be more accurate to call song "musical speech," using the word "musical" in its strict sense as signifying sound with definite variations of tone and regularity of time. But, just as there may be "songs without words," so there may be speech without voice, as in whispering. Sound, as we have already seen, is produced in the larynx, but articulation, or the transformation of meaningless sound into speech, is performed in the mouth; in speaking, therefore, the two parts work together, the larynx sending out a stream of sound, and the mouth, by means of the tongue, cheeks, palate, teeth, and lips, breaking it up into variously formed jets of words. In other words, the larynx supplies the raw material of sound which the mouth manufactures into speech. Time, which is an essential element of song, is altogether disregarded in speech, while the intervals of tone are so irregular as to defy notation, and are filled up with a number of intermediate sounds instead of being sharply defined. The voice glides about at its own sweet will in speaking, obeying no rule whatever, while in song it springs or drops from one tone to the next over strictly measured gaps. In singing, short syllables are lengthened out and cease in fact to be short, and (except in certain kinds of dramatic singing and in recitative) the accent naturally falls on the vowels and not on the consonants. In speaking, only the lower third of the voice is employed as a rule, while in singing the greatest effect is generally produced, except in the case of contraltos and basses, by the use of the upper and middle notes. In speech the range of tone, even in the most excitable persons, hardly ever exceeds half an octave; in singing the average compass is two octaves. Singing tends to preserve purity of language, the rules which govern the utterance of every note also affecting the articulate element combined with it, and keeping the words cast in fixed forms—a stereotype of sound, if I may venture the metaphor. Speech, on the other hand, like handwriting, is always changing. As Max Müller says: "A struggle for life is constantly going on among the words and grammatical forms in each language. The better, the shorter, the easier forms are constantly gaining the upper hand, and they owe their success to their own inherent virtue."* Thus speech not only tends to split language into dia-

* "Nature," January 6, 1870.

lects, but each dialect is being continually, though imperceptibly, modified not only in construction but in pronunciation. The pronunciation of an Englishman of Chaucer's day would be unintelligible to us, while that of one of Shakespeare's contemporaries would be as strange to our ears as the accent of an Aberdeen fishwife is to the average cockney. If the speaking voice has a distinctly sing-song character—that is to say, if it proceeds by musical intervals—the result is as grotesque as it would be to talk in blank verse, or, as Sir Toby Belch says, "to go to church in a galliard and come home in a coranto." On the other hand, the speaking voice becomes most sympathetic in its quality when it approaches the singing voice, the musical character, however, being concealed by the variety of its inflections. It is important that in speaking a musical note should never be recognized; the effect is as unpleasant to our ears as an accidental hexameter in a sentence of prose was to the ancients.

Wide as the difference is between speech and song, the great gulf fixed between them is partly filled up by intermediate modes of using the voice which partake of the nature of both. Thus there is the measured utterance of declamation, which may be so rhythmical in time and varied in tone as to be almost song. On the other hand, the *recitativo* of the opera approaches speech. Various intermediate forms between speech and song may be heard in the ordinary speech of certain races, notably in Italians, Welshmen, and the inhabitants of certain parts of Scotland and England. The Puritans, as is well known, uttered their formal and affected diction in a peculiar nasal tone; and the term "cant," though properly belonging to their sing-song delivery, came to be applied to the sentiments expressed by it. Many of the ancient orators, to judge from the description left us by Cicero and Quintilian, would seem to have *sung* their speeches, the style of declamation being, in fact, expressly termed *cantus obscurior*. As they generally spoke in the open air, and to vast audiences, this artificial mode of delivery may have been necessary in order to make the voice reach farther than if they had spoken in a more natural way. C. Gracchus used to have a musician behind him while he spoke, to give him the *note* from time to time with a musical instrument called a *tonarion*. A similar plan might, with much advantage to the "general ear," be adopted by certain modern orators, the *crescendo* of whose enthusiasm expresses itself in increasing intensity of shrillness.

Those who have not given much attention to the subject are apt to think of speaking, as Dogberry did of reading and writing, that it "comes by nature"—that it is, in fact, an instinctive act, which no more needs cultivation for its right performance than eating or sleeping. This is a great mistake. Speaking, even of

that slipshod kind which is mostly used in ordinary conversation, is an *art*, and as such has to be *learned*, often with much labor. The complicated muscular actions, the nice nervous adjustments, the combination of these into one harmonious effort directed to a particular end, and, finally, the mastery of all these movements till they can be produced automatically without a direct and continuous exercise of will-power, form a complex process which takes years to learn, and which by many is even then very imperfectly acquired. Good speaking is a higher development of the art, which bears the same relation to speech as ordinarily heard that the horsemanship of an Archer or a Cannon bears to the performance of a costermonger's boy on the paternal donkey.

A man who speaks well not only makes himself intelligible to his hearers without difficulty to them, but with a minimum of effort on his own part. If the voice is properly used, the throat hardly ever suffers, but wrong production is a fertile source of discomfort and even disease in that region. It should be clearly understood that public speaking, in addition to its intellectual aspects, is a physical performance which requires "wind" and "muscle" and the perfect management of one's bodily resources, like any other athletic feat. To attempt to speak in public without previous training is like trying to climb the Matterhorn without preparation, and is just as certain to end in failure if not disaster.

It is hardly an exaggeration to say that the training of the voice should begin almost in the cradle. I do not, of course, mean that a baby should be taught to squall according to rule, or that the prattle of children should be made a laborious task. But I wish to insist on the importance of surrounding the child, as soon as it begins to lisp, with persons who speak well. "All languages," as old Roger Ascham says, "both learned and mother tongues, are begotten and gotten solely by imitation. For as ye use to hear so ye learn to speak; if you hear no other ye speak not yourself; and whom ye only hear of them ye only learn." Quintilian says: "Before all . . . let the nurses speak properly. The boy will hear them first, and will try to shape his words by imitating them." This applies chiefly to pronunciation and the correct use of words; but much might also be done for the right management of the voice if every child could grow up among people who speak well. I should be disposed to make it an essential point in the selection of a nurse or governess that she should have a good voice as well as a refined accent.

In antiquity the training of an orator was almost as elaborate an affair as the training of a race-horse is with us. Not only the voice, but the whole man, physical, intellectual, and moral, was carefully prepared, with conscientious minuteness of detail, for

the great business of life, the making of speeches. In this system of education the development of the voice naturally held a large place, and the *phonascus*, or voice-driller, was an indispensable accessory, not only of every school of oratory, but of many formed orators. Of the methods of the *phonascus* we know little, but we find hints in some of the classical writers that, like certain of his professional brethren in more recent days, he was not disinclined to magnify his office. Seneca, in one of his letters, warns his friend against living, vocally speaking, in subjection to his *phonascus*, and implies that he might as well keep another artist to superintend his walking. In our own day the *phonascus* still survives in public life, though perhaps more as a luxury than an acknowledged necessity. A celebrated novelist, dramatic author, and orator, who passed over to the great majority many years ago, used always to put himself under the guidance of a vocal mentor before delivering a speech. Every tone, every pose, and every gesture was carefully prepared and industriously practiced, under the direction of Mr. Frederick Webster, brother of the celebrated comedian, Benjamin Webster. That the elaborate training of the ancients was eminently successful is shown by the powers of endurance which it is clear they must have possessed. They habitually spoke for five or six hours, and even longer, and, in order to appreciate their staying power, it must be remembered that they spoke in the open air, amid all the tumult of the forum, which was capable of holding eighty thousand people, and with an amount and vigor of action of which the gesticulations of an Italian preacher are but a pale reflex. Long-windedness was at one time cultivated as a fine art by Roman orators, when they had to plead before a judge whom they supposed to be in favor of the other side. These prototypes of our modern obstructionists were aptly termed *moratores*, or delayers, because they postponed as far as possible the passing of the sentence. The abuse finally reached such a height that a law had to be passed limiting the length of pleadings in public cases to the running out of one clepsydra. It is impossible to say exactly what period of time this was equivalent to, as the water-clocks of the Romans were of different sizes, and the rapidity of flow must have varied under different circumstances; from twenty minutes to half an hour may, however, be taken as roughly representing the average length of a speech under this strict system of "closure." On the whole, I think we use the voice in public even more than the ancients, and there is, therefore, all the more reason for its being properly trained. Good speaking is nowadays important, not only from the artistic but from the business point of view; and, even for "practical men," it can not be a waste of time to acquire so valuable a faculty. These arguments may perhaps seem superfluous, as the proposition they

are intended to support is self-evident. I lay stress on them, however, because I am convinced that the necessity of training the speaking voice is very imperfectly appreciated by most people.

It is not within my province to discuss the technical details of voice-training. I will only say that every system of vocal instruction should aim at strengthening the power of the voice, increasing its compass, and purifying its tone, and, above all, at giving the speaker perfect control over it, even in the very whirlwind of oratorical passion. It would be well if every school in the land had a master of elocution attached to it, and if the art of delivery were taught to every boy as part of the regular course of education. In the excellent system of education which Rabelais sketched out, the development of the voice is expressly mentioned as part of Gargantua's athletic training. In the middle of a detailed description of his swimming and climbing exercises and practice in the use of weapons of all kinds, we are told that "pour s'exercer le thorax et poulmons crioit comme tous les diables. Je l'ouy une fois appellant Eudemon depuis la porte Sainct Victor jusques à Montmartre. Stentor n'eut onques telle voix à la bataille de Troye."* There is a hint for schoolmasters of the present day. The "young barbarians" under their charge might by degrees be made to look on strength and beauty of voice, and skill in using it, as an *athletic* distinction; this would at once ennoble the subject in their eyes, and make elocution a matter of keen competition.

As part of the general vocal training which I think desirable, I should be disposed to urge that *all* children and young people should learn to sing as far as their natural capacity will allow. Even those with little or no musical endowment will thus learn to use their voices better in speaking. I may say here, though it is rather anticipating, that, if I think it desirable for speakers to learn to sing, I think it still more necessary that singers should learn to speak. Too many of those who soar aloft on the wings of song despise the *musa pedestris* of speech, and take no trouble to acquire what they look upon as an inferior and possibly superfluous accomplishment—with what result is known to cultivated listeners whose ears have been tortured by the uncouth distortions and mutilations to which singers often subject the words they have to utter.

Of the management of the voice I can not say much here. The chief thing is that the speaker should make himself distinctly heard by the whole of the audience, and to this end art serves better than loudness. A weak voice, properly managed, will carry farther than a powerful organ worked by sheer brute

* For exercise, his throat and lungs cried out like all the devils. I once heard him calling Eudemon from the *Porte* Saint Victor to Montmartre. Stentor in the Trojan War had no such voice.

force. Mr. Bright's use of his voice always gave one the impression of a large reserve of power. There seemed to be no effort in his delivery, even when speaking to a mighty concourse of people, and yet his voice was

> "To the last verge of the vast audience sent,
> And played with each wild passion as it went."

One element of success in this matter is no doubt the art of compelling an audience to listen. As Montaigne, in his quaint old French, says: "La parole est moitié à celuy qui parle, moitié à celuy qui l'escoute; celuy cy se doibt préparer à la recevoir, selon le bransle qu'elle prend: comme entre ceulx qui jouent à la paulme, celuy qui soubstient se desmarche et s'appreste, selon qu'il veoid remuer celuy qui luy jecte le coup et selon la forme du coup."* Every speaker should know the exact limits of his own vocal powers, and he must be careful never to go beyond them, for the sake of his hearers no less than his own. He must learn to judge instinctively of distance, so as to throw his voice to the farthest part of his audience. A speaker, and, I may say, a singer also, should not hear his own voice too loudly. Artistes and orators are often very much disappointed, and think their voice is not traveling well when they themselves do not hear it very distinctly. The fact is that when the speaker does not hear his voice this proves that it reaches to a distant part of the room, and that there is very little rebound. Here I may remark that we never hear our voices as other people hear them. Our own voices are conveyed to the auditory nerve, not only through the outside air, but more directly from the inside, through the Eustachian tube, as well as through the muscles and bones of the mouth and head; the singer not only hears his own voice from a different quarter, as we may say, but he hears besides the contraction of his own muscles. The fact is well illustrated by the phonograph: a listener can recognize other people's voices, but if he speaks into the phonograph, and afterward reproduces his own voice, it does not sound at all like itself to him, because he does not hear it in the manner he is accustomed to, and because he hears it stripped of the various accompanying sounds which are usually associated with it to his ear.

The acoustic peculiarities of the place in which he has to speak must, if possible, be carefully studied beforehand by the orator. Public buildings, however, vary so greatly in their size and construction that it is impossible to lay down any general rules for the guidance of speakers in this matter. Each hall, church, court, and theatre has its own acoustic character, which can be learned

* Speech belongs half to the speaker and half to the hearer; the latter should prepare himself to receive it, according to the impetus it obtains. As with tennis-players, the one to whom the ball is served poses and makes ready according to the motions of the server and the form of the service.

only by experience; the voice must be, as it were, *tuned* to it. It is well if this experience can be gained by the orator before he faces his audience; but he must remember that trying his voice in an empty room is an altogether different thing from actually using it in the same place packed with a solid mass of wheezing, coughing, and perspiring humanity. Handel is said to have comforted himself, when one of his oratorios had been performed to empty benches, by the reflection that "it made ze moosic shound all ze better," but this consolation is denied to the orator. There are some buildings which are so utterly bad from the acoustic point of view that even experienced speakers are little better off than novices. The House of Lords has, or used to have, an unenviable reputation in this respect. A story is told of the late Lord Lyttelton that, after exhausting his voice in vain efforts to make his brother peers hear a motion which he wished to propose, he in despair wrote it down and asked the clerk at the table to read it out. That functionary, however, was quite unable to decipher the writing, and Lord Lyttelton complained that he was cut off from communication with his fellows. Science has not always been successful in coping with the acoustic difficulty. In 1848 it was so difficult for speakers to make themselves heard in the French Chamber, that a committee, consisting of the leading scientific luminaries of the day—such as Arago, Babinet, Dumas (the chemist, not the author of "The Three Musketeers"), Becquerel, Chevreul (the centenarian who died the other day), Pouillet, Regnault, and Duhamel—was appointed to study the case and suggest a remedy. After numerous experiments they hit on a contrivance, designed on the most scientific principles, which was to make the orator's voice ring like a clarion to the farthest benches. The last state of the speaker, however, was worse than the first; he felt as if his voice was stifled under a huge night-cap, and the highly scientific sound-reflector had to be discarded as a failure. Indeed, modern public buildings are so often defective in this respect that I am not surprised to find M. Ch. Garnier, who designed the Grand Opéra in Paris, exclaiming dolefully, "The science of theatrical acoustics is still in its infancy, and the result in any given case is uncertain." So impressed is he with the shortcomings of modern architecture as regards the conveyance of sound, that he frankly confesses that, in the construction of the Opera-House, he "had no guide, adopted no principle, based his design on no theory"; he simply left the acoustic properties of the building to *chance*. The result has not been altogether satisfactory, though it has been no worse than in many other buildings where the architect did his best to make the acoustic conditions perfect. One of the most remarkable buildings from the acoustic point of view that I have ever seen is the beehive-shaped Temple in Salt Lake City. It

holds from twelve to fourteen thousand people, and one can literally hear a pin fall. When I was in the Temple, with some other travelers, in 1882, the functionary corresponding to the verger of ordinary churches stood at the farthest end and dropped a pin into his hat. The sound of its fall was most distinctly audible to all present. The scratching of the pin against the side of the hat was also plainly heard across the whole breadth of the building. The Temple was designed by Brigham Young, who professed to have been directly inspired by the Almighty in the matter, as he knew nothing of acoustics. The resonance of the building is so loud that branches of trees have to be suspended from the ceiling in several places in order to diminish it. It is likely enough that Brigham Young's inspiration had a not very recondite and purely terrestrial source, for his Beehive is only a slight modification of the whispering-gallery in St. Paul's. The bad acoustic properties of buildings may be remedied by what doctors call "palliative treatment." Charles Dickens's experience as a public reader made him a man of ready resource in meeting such difficulties. On one occasion, when he was going to lecture at Leeds, Mr. Edmund Yates, who had spoken in the same hall the evening before, sent him word that the acoustic conditions of the place were very bad. Dickens at once telegraphed instructions that curtains should be hung round the walls at the back of the gallery; by this means he was able to make himself more easily heard.

The speaker should take the greatest care of his voice, which is the instrument both of his usefulness and of his fame, but of course it is not always easy for him to do so. Still, he should, if possible, make it a rule not to speak when his voice is hoarse or fatigued, and, when he has a great oratorical effort to make, he should reserve himself for it. Tobacco, alcohol, and fiery condiments of all kinds are best avoided by those who have to speak much, or at least they should be used in strict moderation. I feel bound to warn speakers addicted to the "herb nicotian" against cigarettes. Like tippling, the effect of cigarette-smoking is cumulative, and the slight but constant absorption of tobacco juice and smoke makes the practice far more noxious in the long run than any other form of smoking. Our forefathers, who used regularly to end their evenings under the table, seemed to have suffered little of the well-known effects of alcohol on the nerves, while the modern tippler, who is never intoxicated, is a being whose whole nervous system may be said to be in a state of chronic inflammation. In like manner cigarette-smokers (those at least who inhale the smoke, and do not merely puff it "from the lips outward," as Carlyle would say) are often in a state of chronic narcotic poisoning. The old jest about the slowness of the poison may seem applicable here, but, though the process may be slow, there can be

little doubt that it is sure. Even if it does not kill the body, it too often kills or greatly impairs the victim's working efficiency and usefulness in life. The local effects of cigarettes in the mouth must also be taken into account by those whose work lies in the direction of public speech. The white spots on the tongue and inside of the cheeks, known as "smoker's patches," are believed by some doctors with special experience to be more common in devotees of the cigarette than in other smokers; this unhealthy condition of the mouth may not only make speaking troublesome, or even painful, but it is now proved to be a predisposing cause of cancer. All fiery or pungent foods, condiments, or drinks tend to cause congestion of the throat, and if this condition becomes chronic it may lead to impairment, if not complete loss, of voice. The supposed miraculous virtues of the mysterious possets and draughts on which some orators pin their faith exist mainly in the imagination of those who use them; at best they do nothing more than lubricate the joints of the vocal machine so as to make it work more smoothly. This is just as well done by means of a glass of plain water. In France water sweetened with sugar is the grand vocal elixir of political orators. As Madame de Girardin said, somewhat unkindly: "Many things can be dispensed with in the Tribune. Talent, wit, conviction, ideas, even memory, can be dispensed with, but not *eau sucrée*." Stimulants may give a sort of "Dutch courage" to the orator, and may carry him successfully through a vocal effort in which indisposition or nervousness might otherwise have caused him to fail, but the immediate good which they do is dearly purchased by the thickening and roughening of the mucous surface of the throat to which they ultimately give rise.

Before leaving the subject of the speaking voice, a word or two may be said on what is more a matter of curious speculation than of practical interest. Is the human voice growing in power and beauty, or is it tending to decay? Certain physiologists assure us that the retina has acquired the power of distinguishing colors by degrees, and that the process will probably continue, so that our descendants will by and by evolve the power of seeing colors now quite unknown to us. On the other hand, it is undeniable that civilization, so far from increasing the keenness of our sight, threatens to make spectacles universally necessary. There can be no doubt that the voice has developed greatly since our "half-human ancestors" wooed each other in the primeval forests, and it is conceivable that it may in time to come acquire the power of producing musical effects at present undreamed of. It is also probable enough that as the voice gains in sweetness it may lose in power, the latter quality being more required in barbarous than in highly civilized conditions. On the other hand, we are taller

and of larger chest-girth than our predecessors even of a not very remote date; it is reasonable, therefore, to suppose that the average lungs and larynx are bigger nowadays, and the air-blast from the lungs stronger. This would appear to justify us in believing that the voice is stronger than it was even two or three centuries ago. There are, however, no facts that I know of to prove it.

Of the *ethnology* of the voice little or nothing is certainly known. Almost the only facts I know of coming under this head are—(1) the superior sonorousness of the Italian voice, and (2) the want of resonance in the voices of some Australian aborigines, which is supposed to be due to the extreme smallness of the hollow spaces in the skull which serve as resonance chambers. Yet there is an infinite diversity in the voices of different nations, arising from difference of physical conformation, habit of speech, climate, etc. It is to our climate that Milton attributed the fact, which strikes all foreigners, that English people speak with the mouth half shut. "For we Englishmen," he says, "being far northerly, do not open our mouths in the cold air wide enough to grace a southern tongue, but are observed by all other nations to speak exceeding close and inward; so that to smatter Latin with an English mouth is as ill a hearing as law French." Then look at our American cousins, in whom it is not the mouth but the nose that is the "peccant part"—is it climate or variation of structure that has wrought the change in their original English speech; or is it simply a twang inherited from their Puritan ancestors, who took their "cant" with them to the New World? Americans, including even so refined a scholar as Mr. Lowell, boast that they alone keep the true tradition of English speech; but I can not believe that our forefathers, "in the spacious times of great Elizabeth," spoke in the accents of Hosea Biglow. The difficulty, or rather impossibility, of studying the variations of the voice under culture has been due to the want of any means of permanently recording its tones. Now, however, that the phonograph has emerged from the condition of a scientific toy, comparative *phonology* may, perhaps, take its place among the sciences. Besides this and other results, Mr. Edison's wonderful instrument will preserve the fame of orators, actors, and singers—hitherto the most evanescent kind of glory, as it had to be taken altogether on trust—in a form as concrete as a picture or a poem. The little revolving cylinders will reproduce "the sound of a voice that is still," and will enable us to have "the little voice set lisping once again" years after our darling has been laid in an untimely grave. There seems to be something almost uncanny in the power of thus permanently enshrining the most fleeting part of man, and reawakening at will the living accents of one who, being dead, yet speaketh to the bodily ear.—*Contemporary Review.*

SKETCH OF PROF. JOHN LE CONTE.

By Prof. W. LE CONTE STEVENS.

THE subject of the present sketch is the Professor of Physics in the University of California, where he has for many years been associated with his brother, the distinguished geologist and writer on evolution. He was the second son of Louis Le Conte, and was born on the 4th of December, 1818, at the family homestead in Liberty County, Georgia. The father was a man of much independence of character, firm and decided, yet kind and gentle, exceedingly fond of investigation, original in thought, but singularly indifferent to popular recognition. He published nothing himself, and would never have become known away from his own home, had not others been appreciative enough of his real merit to give some of his results to the world by presenting them before the New York Lyceum of Natural History.

By personal influence and example, Louis Le Conte inculcated in his sons the love of science, and of truth for its own sake. The virtue of verification was one which he sought to cultivate in them as of cardinal importance. An illustration of the success of his teaching in this direction, and of the early growth of the philosophical habit of mind in his son John, was afforded on one occasion when the father and a number of neighbors, while patrolling at night to check some illicit transactions between the negro slaves and the shopkeepers of the nearest village, were fired upon with blank cartridges, and thrown from their startled horses. Relating the story of his mishap after he had reached home, the father said, "I lost my left stirrup; at the turn in the road I lost the other stirrup, and at the next turn I was thrown." John, who listened to the narrative with great interest, was perplexed to know how the stirrups could have been lost. His night's rest did not remove the trouble, and, leaving his bed before sunrise, he went and examined the saddle. He reported upon the result of his investigation at the breakfast-table. "Pa, did you not say last night that, when the horse ran away with you, you lost your stirrups?" "Yes, my son, I did say so." "Well, I have found that the stirrups are safe and sound." The laugh was turned against the son, and the father often told the story afterward as a joke upon him. It was, however, no joke; it was a prediction of the career of the future investigator in physics.

The childhood and most of the boyhood of John Le Conte were spent at the plantation home in Georgia, where hunting, fishing, boating, and all kinds of athletic sports contributed largely to the training of his observing faculties. His uncle, Major Le Conte,

an accomplished zoölogist, often gave up his New York home in winter for the purpose of spending the colder months on the Southern plantation. The scientific proclivities of both father and uncle insensibly made all the children students of natural history and collectors of specimens. Thus they gradually imbibed knowledge on such subjects, and acquired powers of discrimination that are ordinarily attained only by years of study in maturer life. Their mother died in 1826, leaving the father in charge of six children. Deprived of maternal care at so early a period of life, all of them, and especially the boys, were thrown largely upon their own resources at a tender age.

In those days and in that country neighborhood, forty miles from the nearest city, Savannah, it was necessary to do without the school accommodations that are now abundant in every village of our land. An isolated wooden-framed house, with no plastering, a single door for its single room, abundant ventilation through the crevices of the floor and walls, fully supplemented by the draught through an ample clay chimney—such was the school-house in which the children were gathered daily from plantations varying in distance from one to half a dozen miles or more. The teacher was rarely ever of the best. One there was who took charge of this road-side seminary for two years, became the intimate friend of Mr. Le Conte, and exerted over his boys an influence that became life-long. Alexander H. Stephens, the future statesman and historian, was then a young graduate who sought in teaching the pecuniary support that was necessary while he was preparing for admission to the bar. His fine classical taste and clear, logical mind produced a lasting impression upon John Le Conte, who received thus his training for college, and entered Franklin College, now the University at Athens, Ga., with distinguished success in January, 1835.

As a student, young Le Conte soon became noted for his clearness of conception and his scrupulous accuracy in work. The curriculum of study was the same for all, irrespective of native bias or prospective aim in life. He was fully appreciative of all the classical culture that was there afforded, but his tastes naturally led him into spending on mathematics and its applications a larger share of attention than Latin and Greek could attract. "Give him the cosine of A and he will prove anything," was the criticism expressed by an admiring fellow-student, and concurred in by the rest. The formal teaching of physics and chemistry involved mere text-book recitation, and attendance upon illustrated lectures of the most elementary character, which were delivered with oracular authority. It was more than whispered among the students that on these topics John Le Conte knew as much as or more than the professor himself.

During his senior year at college Mr. Le Conte was bereft of his devoted father, who died after a very brief illness. This calamity hastened his selection of a profession. In August, 1838, he was graduated with high honor. Immediately afterward he began the study of medicine, and in the spring of 1839 he entered the College of Physicians and Surgeons in New York, where, in March, 1841, he received the degree of Doctor of Medicine. A few months before his graduation in medicine another domestic calamity befell him in the death of his eldest brother, William, to whom had been committed the charge of the family estates in Georgia. This event hastened Dr. Le Conte's return home in the spring of 1841, to take charge of the estate as the eldest surviving son, and frustrated the execution of a cherished plan for supplementing his medical education by a year's residence in Paris.

During the summer of 1841 Dr. Le Conte returned to New York, and was married in July to Miss Josephine Graham, of that city, an accomplished young lady of Scottish and English extraction. The deep love and earnest devotion, and the consequent domestic happiness which crowned this union, contributed more than all else afterward to fortify and sustain him in the battle of life. Mrs. Le Conte was a woman of wonderful personal magnetism, queenly in bearing, and of extraordinary beauty. Her brilliancy and wit, her quick insight and ready tact, added to her majestic presence, made her the center of attraction in every social gathering. In after-years, especially at the annual meetings of the American Association for the Advancement of Science, such men as Bache, Peirce, Henry, and Agassiz vied with each other in doing her homage. Her fame in social circles equaled that of her husband among men of science; and no important step in his life has been taken without acknowledgment of the help derived from the social influence of a wife of whom he was justly proud.

In the autumn of 1842 Dr. Le Conte established himself as a practitioner of medicine in Savannah, Georgia. His four years of residence in that city formed no exception to the usual experience of a young doctor: a very small practice and an increasing family. It afforded, however, an excellent opportunity for study and research, and it was during this period that he made his most important contributions to medical literature. These at once established his reputation in the profession as an acute observer, cautious, exact, and industrious. The first of them, entitled "A Case of Carcinoma of the Stomach," published in the "New York Medical Gazette" in 1842, was the initial outcome of a series of observations on cancer that has been continued from time to time, even after Dr. Le Conte's abandonment of the practice of medicine. At this period he probably paid more attention to physiology than to any other of the departments included in medical science, and his

fondness for research interfered to some extent with the efforts that might have been made to secure paying patients.

In August, 1846, Dr. Le Conte accepted the chair of Natural Philosophy and Chemistry in Franklin College, his *alma mater*, from which he had gone forth eight years before as the best scientific student in his class. This decided his withdrawal from the field of practical work in medicine. Henceforth he devoted himself to the study of physical science, but without failing to keep pace still with the progress of physiology. He retained his professorship at Athens for nine years, resigning it in the autumn of 1855 to become lecturer on chemistry in the College of Physicians and Surgeons, his medical *alma mater*. In the spring of 1856, at the conclusion of his course of lectures in New York, he accepted a call to the South Carolina College at Columbia, where he had been unanimously elected to fill the chair, then first created, of Natural and Mechanical Philosophy. This position he held until the college was disbanded soon after the opening of the civil war. He was then put in charge of the Niter and Mining Bureau of South Carolina. In 1866 the University of South Carolina was organized, and Dr. Le Conte was elected to the same chair that he had held in the college of which this was the new development. This position he retained until 1869, when he gave up his residence in Columbia to become an adopted citizen of California. Here his home has continued up to the present time.

The period of thirteen years embracing Dr. Le Conte's connection with the South Carolina College and University, although clouded by the saddening events incident to the civil war, constituted the pleasantest and most satisfactory period of his life. The institution was governed by a board of trustees composed of gentlemen of refinement and culture, who entertained a genuine sympathy for the labors of the student who strives to plant himself at the most advanced outposts of science and literature. The community amid which the college had been developed was strongly influenced by the atmosphere of scholarship which it produced. There was a quiet spirit of encouragement to learning, which, by its freedom from pretension, furnished the most grateful incentive to study. It was during these years that Dr. Le Conte established a European reputation through his writings, which were published chiefly in the "American Journal of Science" and the "London Philosophical Magazine." It was in 1857 that he made the remarkable discovery of the sensitiveness of flame to musical vibrations—a discovery which served as the starting-point for Barrett, Tyndall, and Koenig in the exquisite applications that have since been worked out by the use of flame for the detection of sounds too delicate for the ear to perceive, and for the optical analysis of compound tones. Unfortunately,

Dr. Le Conte did not possess the wealth of instrumental appliances needed for the development of his unique discovery, but his priority was gracefully proclaimed by Tyndall in the now classic book on sound, made up of lectures delivered at the Royal Institution. Among other papers that attracted marked attention in Europe was one "On the Adequacy of Laplace's Explanation to account for the Discrepancy between the Computed and the Observed Velocity of Sound in Air and Gases," written in 1861 and published in 1864. Laplace's modification of Newton's formula had been questioned by eminent English mathematicians and physicists. Dr. Le Conte showed that the obscurity into which the subject had been thrown was due to misconception of the physical theory of Laplace, and to the difficulties and obscurities which invest the mathematical theory of partial differential equations in their application to physical questions. This paper evoked replies from Profs. Challis, Earnshaw, and Potter, in England; but the American physicist's position is generally accepted today. The paper is a model of exact physical reasoning. In addition to the discussion of Laplace's views, it contains an original investigation of the bearing of the phenomena attending the propagation of sound in air on the question whether the gases constituting our atmosphere are in a state of mixture or of combination.

Just before the close of the war the home of Dr. Le Conte was included in the belt of desolation that was left by General Sherman's march through South Carolina. Among the losses by fire was the manuscript of a volume on general physics, the product of Dr. Le Conte's many years of experience as a teacher and student of this subject. The tribulations of the reconstruction period in South Carolina during the years following the war made scientific investigation impossible. The political turmoil, and the inauguration of the rule of ignorance and vice in place of intelligence, left no refuge but expatriation for those whose occupations depended upon the embellishments of civilization. To this source of disquietude was added the burden of domestic affliction in the loss of an only daughter in the bloom of early womanhood.

At this critical time came a call to the Pacific coast, to assume the chair of Physics and Industrial Mechanics in the University of California, which was then in the incipiency of its organization. The offer was accepted, and Dr. Le Conte arrived in San Francisco in April, 1869. Being immediately appointed acting president, he drew up the first prospectus of the university, in which was set forth a synopsis of the proposed courses of instruction. In September of the same year exercises were begun in temporary buildings at Oakland, where during the following summer he conferred the baccalaureate degree on three young men,

and then retired from executive duties in order to build up more thoroughly his own department of work. On the resignation of President Gilman in 1875, Dr. Le Conte was induced again to assume the presidency, which he retained until June, 1881, but still performing the duties of his professorship. Since that date he has confined himself to his chair of Physics.

Through nearly the whole of life the two brothers, John and Joseph Le Conte, have been closely associated, each attaining eminence, the elder as a physicist, the younger as a geologist. The elder preceded the younger by six years at Franklin College, in Georgia. They went almost together to the South Carolina College, and likewise to the University of California. This fact has often led to their names becoming confounded by strangers.

Dr. Le Conte is a member of the National Academy of Sciences, the American Association for the Advancement of Science, the American Philosophical Society and Academy of Natural Sciences in Philadelphia, the New York Academy of Sciences, and the California Academy of Sciences. To this list might be added various other bodies which have bestowed upon him honorary membership.

A list of some of the more important of Dr. Le Conte's published writings is appended. The entire list is too long for insertion, amounting to about a hundred papers.

Of the first dozen, which show the direction of his tastes as a physician, perhaps the most interesting is No. 9, in which by original experiments he proved that the alligator is able to execute deliberate and determinate movements after decapitation and even after destruction of the spinal cord.

In No. 10 he shows that the mortality from cancer has increased in modern times; that it augments regularly with increasing age, and that it is greater in France than in England. The same subject is pursued still further in No. 28 and No. 49, in which he shows important errors in the usual methods of interpreting vital statistics, and that the average mortality from cancer is fully three times as great among females as among males.

In No. 16 he gives the first rational explanation of a whole class of ice phenomena as manifested both in the ground and in plants. In No. 17 the investigation is continued, and from numerous experiments it is shown that many plants may be completely frozen without injury.

No. 19 is a criticism of Moseley's theory of the descent of glaciers, in which it is demonstrated that the descent can not be produced by expansions and contractions of the ice due to changes of temperature.

In No. 20 it is shown that Maury's theory of the winds is un-

tenable. This conclusion is now universally accepted, great as was the value of Maury's work in the pioneer days of meteorology.

In No. 23 it is shown that solar light has no sensible influence on combustion. This paper, as well as Nos. 16 and 17, was extensively reproduced in Europe. The same remark applies to Nos. 24 and 26, which have been already discussed.

In Nos. 25 and 39 an account is given of investigations regarding the depth, transparency, and color-tints displayed in some remarkable bodies of water.

No. 35 contains the description and discussion of some unique experiments on the propagation of vibrations through water, the source of disturbance being explosions of great violence. The results were wholly new, and attracted much attention in Europe.

In Nos. 37 and 41 the principles of capillarity are very thoroughly discussed, and illustrated by some new experiments.

Many others of these papers might be summarized, but only by exceeding the limits of a brief biographical sketch.

SCIENTIFIC.

1. "Case of Carcinoma of the Stomach" ("New York Medical Gazette," 1842).

2. "On the Mechanism of Vomiting" ("New York Lancet," 1842).

3. "On Carcinoma in General, and Cancer of the Stomach" (ibid., 1842).

4. "On the Explanation of the Difference in Size of the Male and Female Urinary Bladder" (ibid., 1842).

5. "An Essay on the Origin of Syphilis" ("New York Journal of Medical and Collateral Sciences," 1844).

6. "Remarks on Cases of Inflamed Knee-Joint" (ibid., 1844).

7. "Extraordinary Effects of a Stroke of Lightning.—Singular Phenomena" (ibid., 1844).

8. Observations on Geophagy" (Southern Medical and Surgical Journal," 1845).

9. "Experiments illustrating the Seat of Volition in the Alligator, or Crocodilus Lucius of Cuvier. With Strictures on the Reflex Theory" ("New York Journal of Medical and Collateral Sciences," 1845 and 1846).

10. "Statistical Researches on Cancer" ("Southern Medical and Surgical Journal," 1846).

11. "On the Quarantine Regulations at Savannah, Ga." ("New York Journal of Medical and Collateral Sciences," 1846).

12. "Remarks on the Physiology of the Voice" ("Southern Medical and Surgical Journal," 1846.

13. "Dr. Bennet Dowler's Contributions to the Natural History of the Alligator" (ibid., 1847).

14. "On Sulphuric Ether" (ibid., 1847).

15. "The Philosophy of Medicine: An Address" (ibid., 1849).

16. "Observations on a Remarkable Exudation of Ice from the Stems of Vegetables, and on a Singular Protrusion of Icy Columns from Certain Kinds of Earth during Frosty Weather" ("Proceedings of the American Association for the Advancement of Science," 1850; also, "Philosophical Magazine," 1850).

17. "Observations on the Freezing of Vegetables, and on the Causes which enable some Plants to endure the Action of Extreme Cold" ("American Journal of Science," 1852; also "Proceedings of the American Association for the Advancement of Science," 1851).

18. "On the Venomous Serpents of Georgia" ("Southern Medical and Surgical Journal," 1853).

19. "On the Descent of Glaciers" ("American Journal of Science," 1855).

20. "Review of Lieutenant M. F. Maury's Work on the 'Physical Geography of the Sea'" ("Southern Quarterly Review," 1856).

21. "The Mechanical Agencies of Heat" (ibid., 1856).

22. "Influence of the Study of the Physical Sciences on the Imaginative Faculties." An Inaugural Address, delivered December 1, 1857 (Columbia, S. C., 1858).

23. "Preliminary Researches on the Alleged Influence of Solar Light on the Process of Combustion" ("American Journal of Science," 1857; also, "Proceedings of the American Association for the Advancement of Science," 1857; and "Philosophical Magazine," 1858).

24. "On the Influence of Musical Sounds on the Flame of a Jet of Coal-Gas" ("American Journal of Science," 1858; "Philosophical Magazine," 1858).

25. "On the Optical Phenomena presented by the Silver Spring in Marion County, Florida (U. S.)," ("American Journal of Science," 1861; also, "Proceedings of the American Association for the Advancement of Science," 1860).

26. "On the Adequacy of Laplace's Explanation to account for the Discrepancy between the Computed and the Observed Velocity of Sound in Air and Gases" ("Philosophical Magazine," 1864).

27. "Limiting Velocity of Meteoric Stones reaching the Surface of the Earth" ("Nature," 1871).

28. "Vital Statistics: Illustrated by the Laws of Mortality from Cancer" ("Western Lancet," 1872).

29. "Heat generated by Meteoric Stones in traversing the Atmosphere" ("Nature," 1872).

30. "The Nebular Hypothesis" ("Popular Science Monthly," 1873).

31. Articles on "Bonanza," "Comstock Lode," and "Death Valley," in "Johnson's Cyclopædia," vol. iv, Appendix, 1876.

32. "Mars and his Moons" ("Popular Science Monthly," 1879).

33. "Origin and Distribution of Lakes; Meteorology of the Pacific Coast" ("Mining and Scientific Press" and Supplement, 1880–'81).

34. "Influence of Modern Methods of popularizing Science" ("Berkeleyan," 1882).

35. "Sound-Shadows in Water" ("American Journal of Science," 1882; also, "Philosophical Magazine," 1882).

36. "Origin of Jointed Structures in Undisturbed Clay and Marl Deposits" ("American Journal of Science," 1882).

37. "Apparent Attractions and Repulsions of Small Floating Bodies" ("American Journal of Science," 1882; also, "Philosophical Magazine," 1882).

38. "Amount of Carbon Dioxide in the Atmosphere" ("Philosophical Magazine," 1882).

39. "Physical Studies of Lake Tahoe" ("Overland Monthly," three papers, 1883–1884).

40. "The Part played by Accident in Discoveries" ("Berkeleyan," 1884).

41. "Horizontal Motions of Small Floating Bodies, in relation to the Validity

and Postulates of the Theory of Capillarity" ("American Journal of Science," 1884; also, "Journal de Physique," 1885).

42. "Criticism of Bassnett's Theory of the Sun" ("Overland Monthly," 1885).

43. "The Evidence of the Senses" ("North American Review," 1885).

44. "The Metric System" ("Overland Monthly," 1885).

45. "Thought Transference" (ibid., 1885).

46. "Barometer Exposure" ("Science," 1886).

47. "Electrical Phenomena on a Mountain" (ibid., 1887).

48. "Standing Tiptoe; a Mechanical Problem" (ibid., 1887).

49. "Vital Statistics, and the True Coefficient of Mortality, illustrated by Cancer" ("Tenth Biennial Report of the State Board of Health of California," 1888).

50. "The Decadence of Truthfulness" (1889).

About fifty additional papers are omitted from this list.

CORRESPONDENCE.

THE MENTAL BIAS OF WITNESSES.

Editor Popular Science Monthly:

IN the recent controversy between Prof. Huxley and Dr. Wace, I was struck by the fact that the latter does not seem to have seen that the truth of the gospel narratives is not so much a matter of literary criticism as of psychological criticism. Though M. Renan prove, with stronger arguments than Dr. Wace attributes to him, that the Gospel of St. Mark was written by an eye-witness, the doubt still remains as to whether the eye-witness could be trusted. We all know that even in this age, from which superstition is supposed to have been eliminated, people can not always be trusted to give an exact account of what they have seen; and how much more would this be likely to be true of the imaginative Oriental! "All the vaporing," as Dr. Wace calls it, "about the great critical operation of the present century" in "Robert Elsmere" is in reference to this point, *the value of human testimony*—not whether such a one wrote at such a time, but just how much he was influenced, when he did write, by his psychological tendencies, and also by the traditions of which he, in common with his fellow-men, was the heir.

When we find in the ancient religions of India, Persia, and Egypt exactly the same supernatural elements that we find in the gospel stories, and sometimes even a resemblance in details, such as there is between certain points in the life of Krishna and of Christ, we can not help drawing the conclusion that these supernaturalisms were, in their essence, survivals from older religions, and, in their attachment to the life of Christ, were a proof of the psychological tendencies of the people of that time toward supernaturalism; but that such conclusions should in any way affect the sincerity of Christ himself is perfectly absurd. Dr. Wace thinks that, unless Christ were what he is claimed by orthodox Christians to be, he would be perjuring himself, for example, in the Lord's Prayer, by addressing "our Father," which must show that he was aware of a special connection between God and himself; it neither shows a special connection nor hypocrisy on the part of Christ, but is a most natural form of expression. Even in the hymns of the "Rig-Veda," probably forming the oldest book in the world, men worshiped Dyaus-Pitar (Heaven-Father), so the conception of "our Father who art in heaven" is far older than the time of Christ. Through the unbiased study of comparative religion—a far better way to arrive at the truth than the study of literary criticism—the figure of Christ is made to stand out as the greatest revealer of absolute truth; and the supernatural elements which have been welded into his gracious life, refined of trivialities which attached to them in other religions, are but the attempt of the human mind to clothe in fitting outward symbol the truth which springs from within.

HELEN A. CLARKE.

PHILADELPHIA.

WHY NOT "COBBLE-UP" THE HUMAN BODY?

Editor Popular Science Monthly:

THE loud trumpeting of Dr. Brown-Séquard's alleged discovery of an "elixir of life" suggests another still more rational and practicable way of securing immortality, accompanied by youth and beauty, which I am amazed that no eminent surgeon has as yet

made a bid for fame by proposing. We are all familiar with the brilliant feats of modern surgery in replacing damaged portions of the human body by sound and healthy parts obtained elsewhere. Autoplasty is one of the wide-reaching benefactions of science. Scalped mill-operatives have been furnished with good-as-new *chevelures* by piecemeal contributions from the heads of accommodating friends. Mangled eyes have been successfully replaced by healthy ones taken from cats and rabbits. For centuries the victims of Oriental despotism have had their noses and ears restored by the skilled "leeches" of India, Turkey, and Persia. So common have become operations for the restoration of noses, eyelids, ears, lips, palates, and trachem, that each of these has received a distinct name in medical literature. Nor have the surgeons stopped with these external organs, but have boldly invaded the interior of the system; and I think it is on record that one surgeon succeeded in saving his patient's life by patching up his cæcum with the intestines of a sheep

Why is not this idea capable of indefinite expansion? We all know that, as a rule, men do not break down like the "Wonderful One-Hoss Shay," which

> "went to pieces all at once—
> All at once, and nothing first—
> Just as bubbles when they burst."

Almost invariably they die from the wearing out or lesion of some one organ.

Now, anatomists tell us that we have not a muscle, nerve, or organ which is not duplicated in some one of the lower animals. This being the case, what is to prevent the skillful surgeon, when he finds that one of his patient's viscera — cranial, thoracic, or abdominal — has become incapable of performing its functions, on account of wearing out or weakness, from removing it, and substituting a brand-new one from some healthy and high-bred animal?

For example, instead of using the pancreatic juice of the lower animals, as Dr. Brown-Séquard proposes, why not transplant the organ which produces it, and thus insure the patient a never-failing supply of the digestive fluid produced on the spot? When a man's pancreas becomes debilitated from years of unremitting toil with fried pork and mince-pies, and goes on a strike, threatening stoppage of all other bodily functions and death, why not skillfully excise it, and put in its place, say, the pancreas of a goat or a pig? The wound heals by first intention; the man's digestion recovers the tone of his boyhood days; the food his wife cooks tastes as well as "the things mother used to make"; existence again becomes sweet music, and he takes a new lease of life, until some other organ breaks down, which can be similarly replaced.

So, on the simple plan of the old lady who made a pair of stockings last a lifetime by knitting on new feet one year and new legs the next, men can readily attain the age of Methuselah, with no other drawbacks than periodic recoveries from surgical operations, which will be no worse than their customary "spells of fever," "attacks of indigestion," "nervous prostration," "malarial poisoning," and the like.

I have endeavored to treat this important subject with proper scientific gravity. I anticipate, however, the ghoulish glee of the professional humorist, who will gloat over the prospect of prominent citizens being alluded to as "well-repaired" instead of "well-preserved" men, and who will give the overworked stove-pipe, mother-in-law, and front gate a rest, in order to exploit the funny possibilities of a mature gentleman who has been patched up until he has the digestive apparatus of a goat, the vocal and respiratory machinery of a donkey, and a cranial cavity filled with the ganglia of a sheep or an intelligent Newfoundland dog.

I anticipate also the moral and scriptural objections of a part of the clergy, as to the effect upon the soul of this incorporation with the beasts of the field.

But all great ideas must encounter this sort of thing, and so mine must perforce endure it.

JOHN MCELROY.

WASHINGTON, D. C.

THE RIGHT TO PROPERTY.

Editor Popular Science Monthly:

IN Mr. Philpott's able essay on "The Origin of Property," in the "Monthly" for September, he quotes Prof. Leslie's notable remarks on the true meaning of the word "property." While there may have been others who have also called attention to the same point, I can not refrain from specially referring Mr. Philpott and your readers to Volume II of the works of the late Thomas Hill Green, a thinker whose acute and lucid discussion of fundamental political notions has received singularly inadequate notice. He frequently touches bottom ground with a firmness characteristic of no other political writer known to me, and in this instance he phrases with especial felicity (Vol. II, "Principles of Political Obligation," pp. 517 *et seq.*) the idea upheld by Mr. Philpott and Prof. Leslie: "Two questions are apt to be mixed up which ought to be kept distinct. One is the question how men came to appropriate; the other, the question how the idea of right has come to be associated with their appropriations. . . . One condition of the existence of property, then, is appropriation. But another condition must be fulfilled in order to constitute property. This is the recognition by others of a man's appropriations as something which they will treat as his, not theirs, and the guarantee to him of his appropriations by means of that

recognition . . . (p. 522). To say that it is a 'law of nature' that a man should have a property in the work of his hands, is no more than saying that that on which a man has imposed his labor is recognized by others as something which should be his, just as he is recognized by them as one that should be his own master. . . . It is only within a society, as a relation between its members, that there can be such a thing as a right, and the right to free life rests on the common will of society. Just as the recognized interest of a society constitutes for each member of it the right to free life, so it constitutes the right to the instruments of such life, and thus through the medium, first of custom, then of law, securing them to each." This is Prof. Leslie's thought in amplified form, and it may be of interest to Mr. Philpott to note the passage.

JOHN H. WIGMORE.

CAMBRIDGE, MASS., *September* 14, 1889.

EDITOR'S TABLE.

A MINORITY BUT NOT A SECT.

A PROTESTANT minister in Oakland, Cal., in a recent address on the subject of the public-school system of the United States, expressed himself as follows: "In one of the schools of San Francisco Herbert Spencer's 'Data of Ethics' was introduced as a text-book of morals—as palpable a violation of the law forbidding sectarian instruction as the introduction of the Catholic or Methodist catechism; for Herbert Spencer belongs to that very small and narrow sect which promulgates the creed of agnosticism." If the reverend speaker had taken the ground that the "Data of Ethics" was too abstruse a book to be placed in the hands of public-school pupils, we should have felt inclined to sustain his objection. But when he says that to introduce such a book is to give a sectarian character to the school in which it is used, we must enter a protest. Science is never sectarian; philosophy is never sectarian. Sectarian teaching begins when you ask a man or a child to assume what can not be proved, for the sake of keeping within the dogmatic lines that fence round some particular creed. The followers of Mr. Spencer may be a minority, but they are no more a sect than were the adherents of the Copernican system of astronomy, or than are the believers in the Darwinian theory of natural selection. Mr. Spencer makes no appeal to faith, but finds his premises in the common experience of mankind. A pupil who was being taught out of the "Data of Ethics" would be quite at liberty to dispute either the premises or the arguments of the author; and he would not be silenced by the declaration that Mr. Spencer was infallible. But when catechisms are taught they are taught, not as containing matter for discussion, but as containing doctrines that must not be disputed, on pain of more or less disagreeable consequences. Similarly, when the Bible is read in school, it is read not as a fallible record of events or a fallible guide in morals, but as something absolutely authoritative—the very voice of God. It is perfectly obvious, then, where sectarianism in education begins: it begins just at the point where doctrines of any kind, accepted on faith by a portion of the community and not discussible on grounds of reason, are made a part of public-school instruction. Sectarianism comes in whenever the teacher is obliged to say "Hush!" to the inquiring scholar who wants his reason satisfied before he will believe. There is no sectarianism, on the other hand, in making use of a book which lays no claim to any kind of privilege, and which, therefore, can not force the belief of any one. The followers of Mr. Spencer do not form a sect, because they have no beliefs which they wish to exempt from criticism or discussion, and because they hold themselves at full lib-

erty to pass beyond the bounds of Mr. Spencer's thought whenever they can see their way to doing so. Mr. Spencer's "Data of Ethics" may not contain all the truth on the subject of morals, but the truth which it does contain lends itself to demonstration; and no one can be the worse for being taught demonstrable truths. Upon that foundation he can afterward build what he likes—hay, stubble, or what not; and after his superstructure has been tried by the fire of experience, as it is very likely to be, he will still have something solid left on which to rebuild in perchance wiser fashion. We do not advocate the introduction of the "Data of Ethics" into the public schools; but we are convinced that it would be a very good thing for the rising generation if some of the ideas contained in that book could be brought home to their minds.

SCIENCE IN DOMESTIC ECONOMY.

Mr. Edward Atkinson's paper on "The Art of Cooking," which opens this number of the "Monthly," is one to which we confidently call the attention of every reader of the magazine. There is no art which concerns the well-being of more persons than cookery. Blunders in navigation do not injure those who stay on land, errors of engineering may easily be escaped, and the mistakes of the apothecary do not affect him who takes no medicine. But none of us can do without eating, and if our food is not properly prepared we are sure to suffer both in health and in pocket. The fact which Mr. Atkinson states in his opening sentence, that "the cost of materials which are used for food comes to one half or more of the average income" of most persons, shows the importance of carefully limiting the percentage of waste in this large item of domestic expenditure; and when we remember that, as he states in the next paragraph, "good health depends in greater measure upon adequate nutrition and upon the conversion of food material into a digestible form than upon any other factor in life," the value of correct principles in cookery, on the score of health, is apparent. Yet the present mode of cooking is far from agreeing with correct principles.

Mr. Atkinson says that almost the whole of the fuel used in cooking in the ordinary way is wasted, while the odors which accompany the process are evidence that the food is losing nutritious properties, and often that it is being converted into an unwholesome condition. The effect of heat on starch, sugar, fats, and albuminoids, and the laws of radiation and conduction, are well enough understood, yet cookery has remained stagnant, while metallurgy, dyeing, soap-making, and other familiar arts, which likewise depend on chemistry and the science of heat, have made gratifying progress. The cooking of the world is practically in the hands of women, and the art is in an undeveloped state. Here is a chance for the sex to prove good their claim to the same mental capabilities as men. Let them give up blind following of recipes and learn to understand processes. Let them experiment, record observations, and invent. If they can not at once rise to the level of original work, let them at least study the investigations and apply the inventions of others. Mr. Atkinson has made experiments in cooking, extending over some years, which have led to the invention of the apparatus described in his article. His "oven" and "cooker" unquestionably prevent the scorching of food, and effect a wonderful economy in fuel, yet he has found it difficult to give away his valuable ideas to the public. We are confident, however, that his article will be read with more interest than, say, twenty years ago. A steadily growing amount of thought is being given to making science serviceable in the preparation of food, and in other matters of household economy. The fact that such men as

Mr. Atkinson and Prof. Mattieu Williams are working in this field, and that their results are received with interest, gives promise that the human race will some time attain to a thoroughly intelligent style of daily life.

LITERARY NOTICES.

THE STRUCTURE AND DISTRIBUTION OF CORAL REEFS. By CHARLES DARWIN. Third Edition, with an Appendix by Prof. T. G. BONNEY. With Illustrations. New York: D. Appleton & Co. Pp. 344. Price, $2.

THE formation of coral reefs was one of the subjects investigated by Darwin during the voyage of the Beagle. The information which he obtained from his own observations and the reports of other investigators, together with the mode of accounting for these structures resulting from his study of this material, are embodied in the present work. The first edition of the book was published in 1842, a brief sketch of the author's views having been read in 1837 before the Geological Society, of London, and published. Darwin's theory of coral reefs speedily won acceptance among men of science, and had been taught in scientific lectures and textbooks for a generation before any considerable rival appeared. In 1874 Darwin issued a revision of his book, containing additional facts obtained by later explorers. The only important work on the subject which had appeared since 1842 was Prof. James D. Dana's "Corals and Coral Reefs," issued in 1872. Prof. Dana had accepted Darwin's theory in the main, though objecting very decidedly to some of its minor features. In 1880 Mr. John Murray, one of the naturalists of the Challenger Expedition, advanced a theory widely at variance with that of Darwin, which has found vigorous supporters, and various modifications of both the leading hypotheses have been offered by later investigators. But the majority of those qualified to judge of this difficult question have shown a disinclination to give up Darwin's theory for that of Murray—so much so that the Duke of Argyll, evidently jealous for Scottish honor, in 1887 accused scientific men of disregarding Murray's work from subserviency to their idolized Darwin. The duke's article was entitled "A Conspiracy of Silence," and drew forth a vigorous reply from Prof. Huxley in the review in which it appeared, besides arousing a spirited discussion in the columns of "Nature." The new edition of "Coral Reefs" affords the means of forming an intelligent opinion as to the merits of Darwin's views. It is, by the way, the first edition that has been published in this country. The body of the work has been left as revised by the author for the second edition, but occasional foot-notes, and an appendix comprising a careful summary of the more important memoirs published since 1874, have been added by Prof. T. G. Bonney. In the first three chapters the three chief classes of coral formations—atolls or lagoon islands, barrier reefs, and fringing or shore reefs—are described. The fourth chapter deals with the distribution of coral reefs and conditions favorable to their increase, their rate of growth, and the depths at which reef-building corals can live. Darwin's theory of the formation of the different classes of coral reefs then follows. Coral polyps do not flourish below a depth of twenty or thirty fathoms, but reefs are found rising from much greater depths—how are these to be accounted for? The theory regards barrier reefs and atolls as having been developed successively from fringing reefs. The latter are so named because they closely skirt the shores of islands and continental land, increasing by growth on the outer edge, where the conditions seem to be most favorable for the life of the corals. Imagine such a reef formed around a volcanic island, and the island then to begin sinking beneath the sea. The reef will be carried down with it, but the active growth at the outer edge will still keep this part at the sea-level, while the inshore part where growth has stopped will become deeply submerged. We now have an island surrounded by a deep channel, outside of which is a ring of coral—that is, an island encircled by a barrier reef. Suppose the subsidence to go still further until the highest point of the island disappears, the growth at the outer edge of the reef still keeping it up to the surface, and there results a ring-shaped reef inclosing a lagoon—that is, an atoll. It can not be denied that this theory accounts for the channel within a barrier reef and the ring shape of atolls, besides answering the question asked above,

all in a very natural way. But it has been objected to on account of the amount of subsidence in the floor of the Pacific and Indian Oceans which it would imply, and for other reasons. Mr. Murray attempts to find a foundation at a suitable depth for the corals to begin work upon without supposing subsidence. He thinks this could be furnished by the accumulation of skeletons of minute animals and plants, upon natural elevations of the sea-floor, although when such remains fall to greater depths they are mostly dissolved by the aid of the carbon dioxide in the water. He thinks that a coral plantation rising on such a base would tend to assume the atoll form owing to the more abundant supply of food to the outer portions, and the removal of dead coral rock from the inner portions by the force of currents and by solution. He believes that barrier reefs have been built out from the shore, and that the channel within them is hollowed out by the same agencies as the lagoon of an atoll. The death of Darwin occurred so soon after the promulgation of this theory that he did not have an opportunity to publish any examination of it, but to a friend, Mr. T. Mellard Reade, who had expressed the opinion in a letter that it was "a very far-fetched idea," he replied: "I am not a fair judge, but I agree with you exactly that Murray's view is far-fetched. It is astonishing that there should be rapid dissolution of carbonate of lime at great depths and near the surface, but not at intermediate depths where he places his mountain-peaks." Besides a statement of Murray's theory, Prof. Bonney's appendix contains abstracts of the views of Alexander Agassiz, H. B. Guppy, G. C. Bourne, Bayley Balfour, W. O. Crosby, and J. D. Dana, together with an expression of his own opinion as to the value of the various objections to Darwin's theory. The volume contains three folded charts, and has an adequate index. It is bound uniformly with the other works of Darwin issued by the same publishers.

NATURAL RELIGION. By F. MAX MÜLLER. London and New York: Longmans, Green & Co. Pp. 608. Price, $5.

THIS book includes the first course of Gifford lectures, twenty in number, delivered by Prof. Müller before the University of Glasgow in 1888. The Gifford lectures rest upon a fund of eighty thousand pounds which was left by Lord Adam Gifford by will in 1885, to be applied in specific sums to the establishment in four Scotch universities of chairs for "Promoting, advancing, teaching, and diffusing the study of Natural Theology," or "the knowledge of God, the Infinite, the All, the first and only cause, . . . the knowledge of his nature and attributes, the knowledge of the relations which men and the whole universe bear to him, the knowledge of the nature and foundation of ethics or morals, and of all obligations and duties thence arising." The will provided for changes of lecturers at short intervals, so that the subject might be presented by different minds; that no tests should be required of them save that they be "able, reverent men, true thinkers, sincere lovers of and earnest inquirers after truth"; and that they should treat their subject as a strictly natural science, and under no restraint. Prof. Müller's course naturally assumes the character of an introduction to the courses that are to follow. Much of it is therefore given to laying down the lines and adjusting the bearings; and the discussions comprised in it touch chiefly upon the three points of the definition of natural religion; the proper method of its treatment; and the materials available for its study. The definition is found in the seventh lecture to be, "Religion consists in the perception of the infinite under such manifestations as are able to influence the moral character of man." Of methods, the historical is preferred as the one most likely to lead to results of permanent value. Its object is to connect the present with the past, to interpret the present by the past, and to discover, if possible, the solution of our present difficulties, by tracing them back to the causes from which they arose. It has to be, and is, defended against the common misapprehension that the historian cares only about facts, without attempting to interpret them; and against the opposite school of philosophers who think that our own inner consciousness is the one and only source from which to draw a knowledge and understanding of natural religion—forgetting that their inner consciousness "is but the surface of the human intellect, resting on stratum upon stratum of an-

cient thought, and often obscured by thick layers of dust and rubbish, formed of the detritus in the historical conflicts between truth and error." The materials for the study are language, myths, customs and laws, and sacred books. In pursuing it, the subject is divided into three branches, according as what is here called the Beyond or the Infinite was perceived, in nature—Physical religion, which was to be the subject of the next course of lectures; in man—Anthropological religion, which meets us again and again in different ages and in widely distant parts of the world; or in the self—Psychological religion, filled with intellectual endeavors after that which lies beyond man, as a self-conscious subject. The last statement corresponds in the Christian religion with the doctrine of the Holy Ghost, by which was meant in the beginning "the Spirit which unites all that is holy within man with the Holy of Holies, or the Infinite beyond the veil of the Ego, or of the merely phenomenal Self."

A Manual of Machine Construction for Engineers, Draughtsmen, and Mechanics, embracing Examples, Rules, Tables, and References. By John Richards. Philadelphia: J. B. Lippincott Company. Pp. 306. Price, $5.

The author of this book enjoys the advantage of an experience of thirty-five years in constructive engineering work, at home and abroad. He is a practical mechanic in metal and wood work, and a designer and constructor of machine-work of all kinds. He has prepared original designs for more than a thousand machines now in common use in America and Europe, and is the author of many papers and a number of valuable treatises on various mechanical subjects. The present work is practical; is not for instruction so much as for direct application, and is intended to meet the every-day wants of the engineer, draughtsman, and mechanic in his workshop. The tables are the result of actual practice, and are worked out from complete drawings. The references are such as are constantly required in real work, and the selection is made by noting for a number of years the relative frequency of references to the different subjects. In points of material content and arrangement, each alternate page is left blank, so as to leave a place for receiving the owner's notes and original matter, the constant accumulation of which will, it is believed, make the work a valuable *vade mecum*. There are other conveniences in arrangement, designed to facilitate the use of the book and the finding of the page, besides helps to the reduction of values. In the general introductory observations, the possibility of determining between what is computable and what not, is considered. Among the particular subjects of the chapters are: "Machine Design," "Bearings for Shafts and Spindles," "Sliding Bearings," "The Transmission of Power," etc., "Steam Machinery" with its details; "Hydraulics," "Mechanical Draughting," "Heat," "Dynamics," "Properties of Materials"; and "Weights, Measures," etc.

The Federal Government of Switzerland. By Bernard Moses, Ph. D. Oakland, Cal.: Pacific Press Publishing Company. Pp. 256. Price, $1.50.

This volume, by the Professor of History and Political Economy in the University of California, comprises a carefully prepared essay on the Constitution of the principal established European republic; one that may give lessons to American citizens, and which is in every way worthy of their study. Prof. Moses approaches the subject with the manner of one who understands it, and treats it philosophically and judiciously, not only describing the provisions of the Swiss Constitution, but investigating their evolution, and finding how they came to be there. In the introduction, having considered the physical conditions of Switzerland and observed the composite character of its population, he draws a contrast between it and the American republics—the United States and those of Spanish origin. The population of Switzerland, various as it is, has grown from prehistoric stock without serious disturbing influences. The populations of the American republics have been formed from elements whose later environment has had little in common with their earlier surroundings, and under conditions where the force of ancient traditions has been weakened by long migrations. Switzerland and the British colonies were predetermined to federation by their geographical positions. Switzerland is the only existing republic that has lived

through the period in which religious wars were a part of the order of the day. Notwithstanding this, and the sharp religious divisions between the cantons, union has prevailed, and a federal government has been established under which both Catholics and Protestants live without serious friction. Another peculiar feature of Switzerland is the prevalence of three distinct and official languages (besides the unofficial Romansch), and the maintenance of as many national characteristics, while in the United States there is a tendency to assimilation in all things of thiskind. The negro in the South introduces a problem into our political life "of which the population of Switzerland gives no hint." Such class distinctions as may exist there are those that may arise in a homogeneous society under the conditions of modern life, or are a survival from the feudal age; but "they are not such as proceed from the existence in the population of different races regarded as inferior and superior." Illiteracy and general ignorance in any part of the population are wanting in Switzerland; "in fact, in no country of the world are the affairs of education administered more zealously or with greater efficiency. The problem of republican government is, therefore, simpler in Switzerland than in America, in spite of the proximity of the Swiss to the monarchical rule of European states." The analysis of the Swiss Constitution is introduced by a review of the "Antecedents of Swiss Federalism," and is applied in succession to the several departments of the government, its foreign and internal relations, the army and finance, "Rights and Privileges," and "The Common Fraternity."

KANT'S CRITICAL PHILOSOPHY FOR ENGLISH READERS. A New and Completed Edition. By JOHN P. MAHAFFY, D. D., and JOHN H. BERNARD, B. D. Vol. II. The Prolegomena translated, with Notes and Appendices. London and New York: Macmillan & Co. Pp. 239. Price, $1.50.

THIS is the second volume of a work whose first volume was noticed in this magazine several months ago. While in the preceding part of this work the editor has taken the more agreeable task of paraphrasing the original, because the "Kritik" is already accessible in English, he has deemed it "due to Kant to put his 'Prolegomena' in all their homeliness literally before the reader." He has reprinted in the appendix the suppressed passages of Kant's first edition of the "Kritik." The work is unfortunately without an index.

The Modern Chess Instructor, Part I, by *W. Steinitz* (G. P. Putnam's Sons), contains elementary explanations for beginners, the description of notations, a telegraphic chess code, an essay on the principles of the game, and analyses of six popular openings, with illustrative games to each opening, while the appendix contains the games of the contest between Messrs. Steinitz and Tschigorin which were played at Havana in January and February, 1889, with annotations by the author. Pp. 193. Price, $1.50.

Prof. *Charles W. Kent*, of the University of Tennessee, has prepared an edition of the old English poem *Elene*, which is ascribed to Cynewulf, with introduction, Latin original, notes, and a complete glossary. The introduction and notes are designed for the use of students, and not with any view to critical purposes. The glossary has been made more complete than is usual in editions of old English poems. From the historical notice in the introduction, it appears that the manuscript of this poem was found in 1822 in the Cathedral Library in Vercelli, and the question of the way it got there has given rise to considerable discussion, with not very definite results. The author is supposed to have been a Northumbrian, and to have lived in the eighth century. The poem is founded on the story of the search for the cross and its discovery by the Empress Helena, wife of Constantine. While the author has followed the story with considerable fidelity, he has not bound himself too closely to it, and those passages which are all his own are the best in the work. Besides the historical and critical introduction, a metrical introduction and a bibliography are given. We last month published a notice of a translation of this and two other old English poems. Ginn & Co., publishers. Pp. 149. Price, 65 cents.

Of two text-books in Greek published by Ginn & Co., Mr. *Isaac Flagg's* edition, with notes, of Euripides's *Iphigenia among the Taurians* commends itself, not only on ac-

count of the superlative literary merit of the tragedy, but also for the editor's excellent critical introductions, in which he gives an account of the growth of the legend of Iphigenia, an analysis of the plot and artistic structure of the work, and a dissertation on the meters and technique. The volume is one of the publishers' "College Series of Greek Authors," edited under the supervision of J. W. White and T. D. Seymour. Pp. 197. Price, $1.50.—Mr. *Addison Hague's Irregular Verbs of Attic Prose* gives, after the regular verbs, pure, mute, and liquid, the irregular verbs in alphabetical order, with prominent meanings and special uses of frequent occurrence, often illustrated by translated examples, the most important compounds, many related words, and some four hundred and fifty English derivatives. The volume constitutes a helpful bridge over a most difficult passage in the study of Greek. Pp. 268. Price, $1.60.

Prof. *S. E. Tillman's Elementary Lessons on Heat* (J. B. Lippincott Company) have been prepared to meet the necessities of a short course of seventy hours at the United States Military Academy. The selection of material has been guided by considerations of the sub-course of studies and of what is essential and most useful for the students to know. A logical arrangement is sought, and clearness and conciseness in relation are aimed at. Most of the experimental illustrations described or referred to are such as can be performed in the lecture-room. The special topics treated of are "Thermometry," "Dilatation of Bodies," "Calorimetry," "Production and Condensation of Vapor," "Change of State," "Hygrometry," "Conduction," "Radiation," "Thermo-Dynamics," and the "Meteorological Aspects of Heat." Pp. 160. Price, $1.80.

The *Manual of Chemistry for the Use of Medical Students* of Dr. *Brandreth Symonds* (P. Blakiston, Son & Co., Philadelphia) is not designed to be a medical chemistry, but takes up those parts of general chemistry which it is necessary for medical students to know. The author, having prepared students for several years in this branch, believes that he knows their needs, and has made this effort, in the light of that knowledge, to supply them. Besides the elements, a large share of the space is allotted to the chemistry of water and air and the substances by which they are polluted; and for this acknowledgment is made to the lectures and articles of Prof. C. F. Chandler. A chapter is given to the tests for the important substances, and another chapter to the tests for urine and the substances that occur in it. The theories of to-day concerning chemical action are briefly presented. The metric weights and measures are also noticed, and the rules are given for converting degrees of temperature. Pp. 154. Price, $2.00.

In an attractive-looking volume of convenient pocket size, entitled *Great Words from Great Americans*, G. P. Putnam's Sons have grouped the Declaration of Independence, the Constitution of the United States, Washington's inaugural and farewell addresses, Lincoln's inaugural and farewell addresses and his great Gettysburg speech, and Washington's circular letter of congratulation and advice to the Governors of the thirteen States, with historical notices on some of the papers, and portraits of Washington and Lincoln. These papers all embody principles and enunciate truths the observance of which is essential to the maintenance of our Government, and which it is important that all citizens should cherish and keep in vigorous life. Pp. 199. Price, 75 cents.

The Kingdom of the Unselfish; or, the Empire of the Wise (Empire Book Bureau, 28 Lafayette Place, New York), has been written by Mr. *John Lord Peck* with reference to the existing stage of social evolution. If not suited to the present state of opinion, it may find a reading in the next century. The purpose of the book is unfolded in the introductory chapter, which is headed "The Reliable and Unreliable in Thought." Of the unreliable are all religious systems founded on tradition and revelation, dogma, and speculative philosophy, including all the systems that have followed one another from Plato and the ancients down to the pessimism of Schopenhauer and Hartmann and the agnosticism of Comte, Huxley, and Spencer. Neither of these last systems "is sufficiently near the final truth to long satisfy the human mind, and the prediction is here ventured that both of them will give way to a system of ontology

more perfect than the evolution philosophy as represented by Herbert Spencer." The class of ideas that is most positive and reliable is found in modern science, which acknowledges nothing as beyond candid criticism, has nothing sacred but the truth, and investigates every part of the universe and of man with equal impartiality; and is not an extreme or antagonistic of all former knowledge and opinion, but "is a more complete, thorough, and systematic knowledge of the same kind as any imperfect knowledge preceding it that has a real basis of fact."

The second volume of the *Report* for 1888 of the Geological Survey of Arkansas, under the direction of State Geologist *John C. Branner*, comprises a review of the *Neozoic Geology of Southwestern Arkansas*, by *Robert T. Hill*. It is the result of the joint work of the United States and the State Surveys, in which the latter was able to avail itself of Prof. Hill's knowledge of the mesozoic geology of other parts of the Union. The region embraced in the present survey may be said roughly to lie between the Ouachita and Red Rivers, extending a little east of the Ouachita, including Little Missouri and Little Rivers, and to consist most largely of the Trinity, Lower and Upper Cretaceous, and Tertiary formations, with plateau gravel and associated deposits, and the flood plains of the rivers, of the Post-tertiary or Quaternary. In determining the relations of the Upper Cretaceous beds, the author concludes that they are identical with those of Texas, more obscurely so with those of New Jersey, and the equivalent of the Upper Cretaceous of Europe. The relations of the Lower Cretaceous and Trinity with formations east of the Mississippi are at present only conjectural. Prof. Hill's review is supplemented by papers on "The Northern Limits of the Mesozoic Rocks in Arkansas," by Prof. O. P. Hay, and "On the Manufacture of Portland Cement," by Prof. Branner. —The third volume of the series is a preliminary report on the *Geology of the Coal Regions*, by *Arthur Winslow*. It contains only a part of the coal regions of the State, representing an area of nearly two thousand square miles and extending about seventy-five miles along the Arkansas River from the Indian Territory to Dardanelle. Chapters are devoted to the "Distribution of the Coal," a review of the coal industry of the State, and the composition and adaptabilities of the coals.

The *Commissioner of Agriculture*, in his *Report* for 1888, represents the year as having been one of much greater activity in the department than it had ever before experienced. The investigations made have excited popular interest, and the results obtained have been helpful to the farming class. A good record was made of the work of the experiment stations. A clearing-house or exchange is called for through which they can co-operate. The most important duty devolving upon the Bureau was the work for eradicating contagious pleuro-pneumonia in cattle; and, in connection with this, the need of a laboratory is suggested where persons can qualify themselves by experiment for practice in the diseases of animals. The division of entomology pursued investigations on the cottony-cushion scale of California, the hop-louse, the root-infesting nematode worms, the cotton and boll worm, which attacked the tomato; the Rocky Mountain locust, the buffalo gnat, and various other insects injurious to vegetation. It is giving attention to the introduction of parasites destructive of such insects. Experiments of silk-culture have not yet given promise of a profitable industry. The chemical division interested itself in the study of food adulterations and processes for making sugar from sorghum. The statistical department had to meet large demands for supplying information. The botanical division was busy in experiments on the adaptation of various plants, and in studies in vegetable pathology. Attention was given to the habits of different birds, and the depredations on crops of various small mammals. The seed division was active in sending out seeds to experimental cultivators and the constituents of members of Congress. The forestry division reported progress, but not much encouragement as yet for the restoration of the forests, or even for the preservation of what of them are left. Microscopical investigations were made in various directions. In pomology experiments are reported on tropical and semitropical fruits and on hardy Russian fruits for the Northwest; and an excellent paper, by Mr. W. H. Ragan,

is published on our wild fruits and the desirability and feasibility of perpetuating, cultivating, and improving them.

Sun and Shade is the name of a monthly "picture periodical without letterpress," published by the *Photo-Gravure Company*, 853 Broadway, New York, which has lately completed its first year. In its growth it has found the taste of its patrons preferring pictures of the higher class, and quality rather than quantity, and announces its purpose in the selection of subjects to respond to this demand. Among its plans for the future are to reproduce the leading pictures in the collection of the Metropolitan Museum of Art and the works of American artists; to encourage the artistic side of direct photography in all its phases; and to add examples of sculpture, architecture, and industrial art. The subjects of "Ecce Homo," "The Return," "Sunshine," "From the Land of Sleepy Hollow," and others, in the August number, each executed in its peculiar style, could hardly be improved upon. Price, 40 cents, a number; $4 a year.

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POPULAR MISCELLANY.

Ancient Aboriginal Mining.—Writing on "Ancient Mining in North America," Prof. Newberry speaks, in the "American Antiquarian," of the great antiquity of the aboriginal works. The ancient copper mines on Lake Superior were abandoned not less than four hundred years ago; for the heaps of rubbish around the pits made by the ancient miners were covered with forest trees that had reached their largest size. The old mica mines of North Carolina and the quarries of serpentine in the Alleghanies showed like evidences of antiquity. Some population in the Mississippi Valley worked the oil-fields in various places. The author, visiting Titusville in 1860, when the first well had been opened, noticed pits in the ground which proved to be relics of the excavations of primeval oil-gatherers. A citizen, digging a well in one of the pits, had discovered and followed an old well, which was cribbed up with timber and contained a primitive ladder, like those which have been found in the old copper mines of Lake Superior. The cribbing had been rudely done with sticks from six to eight inches in diameter, which had been cut or split by a very dull instrument, "undoubtedly a stone hatchet." The oil was probably gathered by being skimmed from the water that collected in the bottom of the pit. Traces of a similar well were observed at Enniskillen, Canada; and depressions in the surface like those on Oil Creek were noticed at Mecca and Grafton, Ohio. Ruins of an ancient lead mine exist on the Morgan farm, near Lexington, Ky., in the form, where they have not been disturbed, of an open cut, from six to ten feet wide, "of unknown depth, and now nearly filled with rubbish. On either side of this trench the material thrown out forms ridges several feet in height, and these are everywhere overgrown by trees, many of which are as large as any found in the forests of that region." Galena has been found in many of the ancient works in Ohio, but has never been smelted, and appears to have been valued merely for its brilliancy. Dr. Newberry does not believe that the mound-builders were of the present Indian stock.

The Law's Neglect of Children.—The defects of English law in regard to the rights and claims of children are pointed out by Mary C. Tabor in the "Contemporary Review." According to Chief-Justice Cockburn, no legal obligation is imposed on the father to maintain his children except under the poor-laws, or unless his neglect shall bring him under the criminal laws. Nor is there any obligation upon him to make provision for them after his death; but, on the other hand, he can by the appointment of guardians exercise almost as absolute a control over them in other respects as if he were living. Responsibility for giving a certain degree of instruction has been imposed by the late Education Act, which the father shares as to children born in wedlock, but as to illegitimate children he is scot-free. The mother of an illegitimate child may, it is true, recover from the father a sum for maintenance, but that obligation is in law due to her only, and in no way to the child itself, which "is shut out from even the shadow of a right to a father's care." The results of so defective a system are what

might have been expected; the working of the Education Act, and of several benevolent enterprises in behalf of children, "have brought to light an appalling amount of semi-starvation, ill-treatment, or neglect, to which children are subjected with impunity at the hands of drunken, dissolute, or idle and improvident parents." Thousands of them do not get a single good meal a day, but come breakfastless to school, and their midday meal is provided by a charity. Cases of neglect and cruelty are brought before magistrates against which no statute provision can be found, so that one officer was driven to declare: "Had it been a dog, I could have helped you; but it is only a child, and I am powerless to assist." The want of paternal responsibility is what drives unmarried mothers to crimes against their offspring. What can they do with them in the situation in which they find themselves? In such cases the author would make the father of the child jointly liable. Matters are better in most of the American States, but in the majority of cases our own provisions lack enormously of what they ought to be. There are practical difficulties in the way of securing adequate protection by law which can not be overlooked; so that the best that can be done will be short of what is desired. But this only enforces the reasons for "doing the best that can be done."

Structure of the Ether.—"We seem," said Prof. Fitzgerald, in the British Association, "to be approaching a theory as to the structure of the ether. There are difficulties connected with diffusion in the simple theory that it is a fluid full of motion, a sort of vortex sponge. There are similar difficulties in the wave theory of light, owing to wave propagation round corners, and there is as great a difficulty in the jelly theory of the ether arising from the freedom of motion of matter through it. It may be found that there is diffusion, or it may be found that there are polarized distributions of fluid kinetic energy which are not unstable when the surfaces are fixed; more than one such is known. Osborne Reynolds has pointed out another, though in my opinion less hopeful, direction in which to look for a theory of the ether. Hard particles are abominations. Perhaps the impenetrability of a vortex would suffice. Oliver Lodge speaks confidently of a sort of chemical union of two opposite kinds of elements forming the ether. The opposite sides of a vortex ring might perchance suit, or may be, the ether, after all, is but an atmosphere of some infra-hydrogen element; these two latter hypotheses may both come to the same thing. Anyway, we are learning daily what sort of properties the ether must have. It must be the means of propagation of light; it must be the means by which electric and magnetic forces exist; it should explain chemical actions, and, if possible, gravity. On the vortex-sponge theory of the ether there is no real difficulty by reason of complexity why it should not explain chemical actions. In fact, there is every reason to expect that very much more complex actions would take place at distances comparable with the size of the vortices than at the distances at which we study the simple phenomena of electro-magnetism. . . The theory that material atoms are simple vortex rings in a perfect liquid otherwise unmoving is insufficient, but with the innumerable possibilities of fluid motion it seems almost impossible but that an explanation of the properties of the universe will be found in this connection."

The "Rabbit Pest" in Australia.—The prevalence of the "rabbit pest" in Australia seems to be largely a result of man's indiscreet interference with the order of nature. Hares were introduced for coursing. Pet rabbits were brought over, and a few pairs of gray rabbits were turned out near Geelong, to form a warren. The last lot are believed to have been the fathers of the mischief, although some of the traits of the pets are found among the pests. The rabbit army generally trends toward the north because it started from too near the ocean to advance south. Night travelers along the Murray River used to describe the noise made by the rabbits scampering off from the coach-lights as something like the pattering of a hail-storm. The colonists made a first mistake in having the dingoes, or native dogs, destroyed, because they were dangerous to the sheep. Then the kangaroos began to multiply, taking advantage of the accommodations provided for the sheep. As soon as they were reduced to manageable

numbers, the rabbits appeared. The twenty or twenty-five million sheep pastured on the Riverina plains are being gradually eaten out by rabbits to an extent which is represented by the decline of the flocks supported at one station from one hundred and ten thousand to twelve hundred head. The rabbits at that station have eaten up and destroyed all the grass and herbage; have barked all the edible shrubs and bushes; and have themselves perished by thousands. Foxes have been introduced for the accommodation of hunters, and in the belief that they might help to keep down the rabbits, and have become an additional and fast-increasing nuisance. Mr. C. G. N. Lockhart, in "Blackwood's Magazine," advises that the rabbits be fought by the encouragement of their natural enemies, cats and iguanas. Cats hunt them industriously, and it may be estimated that the progeny of one pair of cats will in the fifth year be equal to the slaughtering in one year of two million and a half of them. Iguanas, in the growing scarcity of opossums, their proper food, may probably learn to eat rabbits. The bounties offered for the destruction of rabbits are actually contributing to their perpetuation. The professional trappers find them a profitable game, and take care to keep up the supply. Hence they make war upon the cats with much more anxiety for their extinction than they show against the rabbits.

The Fate of the Gulf Stream.—M. J. Thoulet, applying the results of some recent observations respecting the relative levels of sea-water, describes the Gulf Stream as like a river, having a crest-line more inclined in the vicinity of its source than toward its mouth; separated by a valley of relatively abrupt inclination from the southward Newfoundland current, while its right flank has a more considerable breadth. Certain currents from the Gulf of St. Lawrence strike it so as to retard its speed and cause the deposition as a submarine delta in the slope of the "banks" which extend along the United States from the Great Bank of Newfoundland; while the eastern polar current, passing around Newfoundland on the east, strikes it perpendicularly. The waters of this current, colder but a little lighter than those of the Gulf Stream, mingle with them, and almost stop it. Its warm waters then spread out, and although they still possess a general direction toward the east, are subject to the impulsion of the winds and other accessory causes affecting the economy of currents. The Gulf Stream is then in the best condition to mollify the climate of western Europe, but no longer has individuality; it has become a simple drift without depth, and may be compared to a great river lost in swamps.

Wild Creatures of the Alps.—Martens and eagles add to the charms of the landscape for the Alpine tourist, but are hunted by the forester as his special enemies. The marten is a great destroyer of eggs and weak young creatures, and even attacks roes during the heavy snows of winter. It steals along by the animal as it labors through the heavy drifts till it becomes exhausted, when he springs upon it, bites its jugular vein, and sucks its life away. The marten does not eat its game, but drinks the blood while it is still warm, and leaves the body for other beasts and the elements. The fox hunts in a similar way, but eats the flesh till it is satisfied, and buries the rest of the carcass. The foresters do not like to pursue their predatory enemies with poison and traps, because, it is said, "they seem to think that they are taking an unfair advantage of a brother sportsman by employing such underhand means of getting rid of him." Still, they will lie in ambush to shoot their rivals. Selecting a conveniently situated building, they attract the foxes toward it by scattering carrion around at a suitable distance. Having learned the hour at which the animals are accustomed to appear, they lie in wait for them, on some moonlight night, and shoot at the shadowy forms as they come in sight. The larger birds are shot in a similar manner, but under circumstances of more labor and discomfort, because they are more wary. While the fox can be waited for in a warm room, with the window closed, the birds have to be watched from some rugged spot where it is impracticable to have a fire, and with open windows. The birds are also hunted for with a decoy horned owl—a creature toward which they are hostile; and some of the foresters keep owls for this work. While the hunters hide in some shel-

ter they have constructed, the owl is tethered upon a branch, with chain-room enough to enable him to reach and move about upon the ground; while a string is led from the chain to the shelter, by means of which the owl is kept in a lively condition. The fluttering of the bird between the ground and the perch attracts the attention of the crows; their circling and cawing are noticed by the hawks and eagles, which come around to see what the crows have found, and are shot.

Doctor and Patient in Ancient Hispaniola.—Some of the curious features and customs of the people which were described by the early travelers in Hispaniola or Hayti have been recalled by Mr. H. Ling Roth, in a paper before the Archæological Institute. The missionary Ramon Pane says that the doctors were dieted along with their patients, and were obliged to purge themselves when they did. Intoxicating himself by snuffing a powder which may have been tobacco, the doctor would say extravagant things. These were regarded as communications from the *Cemis* or fetich, and as embodying revelations of the origin of the sickness. Having put into his mouth a package of small bones and flesh and gone through some preliminary observances, the doctor would go toward the sick man and turn him twice about; then, standing before him, take him by the legs, feel his thighs, descending by degrees to his feet, and draw hard, as if he would pull something off; then, going to the door, he would shut it, saying, "Begone to the mountain, or to the sea, or whither thou wilt!" With this he would give a blast as if he were blowing something away, turn about, clap his hands together, and shut his mouth, while his hands would be quaking as if he were a-cold. Then he would blow on his hands, and drawing in his blast as if sucking the marrow of a bone, he would suck at various parts of the man's body. This done, after a coughing and making of faces, as if they had eaten some bitter thing, the doctor would pull out what he had put into his mouth before starting out. If it was anything eatable, he would tell his patient that the *Cemis* had put it into him to cause the distemper because he had not made a suitable offering to it. If the patient died, and his friends were strong enough to oppose the physician, they would mix with the juice of a certain herb and the dead man's nails and forehead hair pounded between two stones, and, pouring it down the dead man's throat and nostrils, ask him whether the physician was the cause of his death. This they would do till the dead man would speak, "as plain as if he were alive," and answer all that they asked of him, when they would return him to his grave. Another method of making the dead speak was to place the body over a very hot fire covered with earth, when the dead would answer ten questions and no more. If the physician had failed to do his duty, he was waylaid and bruised, but a particular mutilation was necessary to secure his death. At night, after the bruising, snakes were believed to lick the doctor's body, and he would tell the people that the *Cemis* had come to his assistance.

Country Life, Past and Present.—As to whether country life is more comfortable now than it was fifty years ago, something may be said on both sides. Most of the places remote from large towns were literally out of the world in the old times, so far as society and active life were concerned. Traveling by public conveyance was difficult, inconvenient, and expensive; and visits to the city were rarely enough made to be with many literally the event of a lifetime, while hosts of other persons never enjoyed them at all. Communication by letter even was not common, for postage was high and graduated according to the distance, and only those who were able to indulge in it as a luxury felt that they could afford to dispatch many letters except on business or in cases of necessity. There were market towns, and they enjoyed a kind of prosperity of their own from which many of them have fallen since railroads came in, and they had their societies and their peculiar codes and usages and games and amusements, which left no lack of sources of enjoyment. But very few now living in those same towns would exchange their present life there for that of the past. There were, however, a sociality and a heartiness in the neighborhood life of those days, a freedom and equality of intercourse among the people of all classes—an ignoring, in fact, of class distinctions—a community of feeling and reciprocal interest

by all in the welfare of all, a wholesome public opinion, and an intelligent public spirit, that have now disappeared. Then Lincoln's ideal of government of the people, for the people, by the people, was realized in thousands of communities where the hope of it and even the imagination of it are not now entertained. We have gained that the value of which we can not calculate with railroads and telegraphs, and the changes which have come over our social life; but it is equally impossible to estimate what, in turn, we have lost.

Deep-Sea Fishes.—Remembering the darkness and the enormous pressure of the water in the depths of the ocean, no one will be surprised that the forms and the organs of deep-sea fishes differ greatly from those of species which live near the surface. Unless among microscopic creatures, no such curious and grotesque shapes can be found in the animal kingdom as among these fishes. Some resemble the ribbon-fishes of our own seas, being long and slender, like the scabbard of a sword. Others are fashioned after the type of our angler-fish, having organs about the mouth suggestive of a bait to attract its prey. Some terminate in a sharply pointed tail instead of the familiar form. One strange form is *Bathypterois longicauda*, of which one specimen only has been taken, from a depth of 2,550 fathoms in the middle of the South Pacific. This fish was three inches long, with a big head and tail and a very slender body. The uppermost pectoral fin was longer than the whole fish, and was forked from its middle. Some species have huge mouths with bodies like loose sacs, capable of prodigious distention when they seize upon a large victim. *Macrurus crassiceps* has a huge head with hardly any body. The hues of deep-sea fish are mostly simple. Their bodies are either black, pink, or silvery; though some which are black when preserved were blue on being brought to the surface. In only a few are some filaments or the fin rays of a scarlet color. Black spots on the fins or dark cross-bars on the body are of extremely rare occurrence. Few people are aware how difficult it is to procure the deep-sea fishes. Their tissues are extremely delicate, so that the dredge often mutilates them. Frequently, too, in coming up from the bottom, on the pressure gradually growing less, the gases which they contain, expanding, tear their way out. Especially is this the case with those which possess a swim-bladder. This is almost always ruptured as the fish comes to the surface. Indeed, some specimens have been found floating in a dying state on the waves, from having seized upon prey which was too powerful for them, and in struggling to escape dragged them into the upper waters, when some rupture took place and they floated helplessly to the surface. The most curious part of the organization of deep-sea fishes is undoubtedly the phosphorescent or luminous organs which distinguish several well-known species. In some of these the eyes seem entirely absent or only rudimentary. Thus, *Ipnops Murrayi*, taken from a depth of 1,600 to 2,150 fathoms, possesses no eyes. It has a depressed head, with a broad snout, and the upper surface of the head is covered with a pair of transparent membranes, carrying a luminous organ divided into two symmetrical halves. *Scopelus* is another phosphorescent species, with a line of "eye-like, pearl-colored organs" running on each side of the fish from head to tail. Dr. Günther, in his "Introduction to the Study of Fishes," has given the possible uses of these organs as, first, to enable the fish to see; second, if placed on barbels and the like, to allure prey; third, to terrify foes. Of course, the luminous appearance departs at death.

If there were no Friction.—Having shown that friction is an insuperable impediment to the realization of perpetual motion, Prof. Hele Shaw observes that "if we are inclined to regret this fact, a little reflection on what would occur if friction ceased to act may not be uninstructive, for the whole face of nature would be at once changed, and much of the dry land, and, even more rapidly, most of our buildings, would disappear beneath the sea. Such inhabitants as remained a short time alive would not only be unable to provide themselves with fire or warmth, but would find their very clothes falling back to the original fiber from which they were made; and if not destroyed in one of many possible ways—such as by falling meteors, no longer dissipated by friction through the air, or by falling masses

of water, no longer retarded by the atmosphere and descending as rain—would be unable to obtain food, from inability to move themselves by any ordinary method of locomotion, or, what would be equally serious, having once started into motion, from being unable to stop except when they came into collision with other unhappy beings or moving bodies. Before long they, with all heavier substances, would disappear forever beneath the waters which would now cover the face of a lifeless world."

British Whales.—The whales of the British Islands are more abundant and more varied in species than has generally been supposed. The most important of the species that have occurred in Great Britain is the Greenland right whale, which has now been driven into the far north. The Atlantic right whale was once hunted with considerable vigor in the English Channel; and those who hunted it there are said to have invented the harpoon, and taught the Dutch whalers how to use it. The hump-backed or Bermuda whale has been cast ashore on the islands, and is therefore entitled to be called a British species. A fourth species is the caaing or bottle-nose whale, a large school of which was seen in the summer of 1888 disporting in the Bay of Firth. The whale—an air-breathing mammal living in the water—is admirably adapted to its environment. The blow-holes are placed on the top of the head, and the animal can respire only when they are above the water. The animal heat is preserved and the specific gravity reduced by the thick coating of blubber that lies just under the skin. An interesting trait in the economy of the whale is the manner in which it suckles its young. It partly turns on its side, and the teats being protruded, sucking and breathing go on simultaneously. The "baleen" or whalebone of the "whalebone whales" consists of about five hundred laminæ—taking the place of teeth—ranged about two thirds of an inch apart, and having their interior edges covered with fringes of hair. Some of them are fifteen feet long. The cavity of a whale's mouth has been compared with that of an ordinary ship's cabin, the inside of which is covered with a thick fur. The soft, spongy tongue is often a monstrous mass ten feet broad and eighteen feet long. The whale feeds upon minute mollusks—*Medusæ* and *Entomostraceæ*—with which the northern seas abound. "Opening its huge mouth," says Prof. Huxley, "and allowing the sea-water, with its multitudinous tenants, to fill the oral cavity, the whale shuts the lower jaw upon the baleen-plates, and, straining out the water through them, swallows the prey stranded upon its vast tongue."

Standards of Light.—It is a delicate matter to obtain an accurate standard of light. Candles are still most relied upon for the tests of comparison, but it is obvious that they are susceptible of great variations in the intensity of the light they afford. Still, if made according to fixed rules, and their burning similarly regulated, they will give a fair approach to accuracy. Various English acts prescribe a sperm candle of six to the pound, and burning at the rate of one hundred and twenty grains per hour; also that the tip of the wick shall be glowing and slightly bent. Gas examiners are not always as particular in the matter as they ought to be, and, by allowing the wick to remain upright, may obtain a result indicating a gas of slightly more value than it really has. The German Gas and Water Society recommend an amyl acetate lamp, which is not quite as intense as a candle, and is objected to by Mr. W. J. Dibdin as being unsuitable in the color of its light. Dr. Werner Siemens has devised a selenium photometer, the electric resistance of which is exactly dependent on the light falling upon it. The pentane lamp, and the Methven screen, in which a coal-gas light is admitted through an aperture of fixed dimensions, are favored by many persons; and a standard afforded by a melting or a solidifying platinum wire is well spoken of.

John Mercer, F. R. S.—John Mercer has been called by Mr. T. E. Thorpe, in "Nature," the "Palissy of calico-printing." He achieved a great success in the arts without any other helps than those which he made for or attracted to himself. He was born, according to Mr. E. A. Parnell's "Life," in 1791, the son of a hand-loom weaver, who had turned to agriculture. When nine years old, he was set to work, on the death of his

father, at bobbin-winding. A pattern-designer taught him reading and writing, and an excise-officer gave him lessons in arithmetic. He became interested in colors and dyeing, when sixteen years old, from observing the orange color of the dress of his little step-brother. Without books or means of obtaining instruction, but having got a full set of colors, and by the aid of trial experiments, he acquired considerable knowledge of the properties of dye-stuffs and of the current methods of coloring. Then he got books and learned exact methods. From this time his course was upward till he became master of his art, the inventor and teacher of new methods, and the author of some of the most valuable improvements that were made in dyeing previous to the introduction of the coal-tar colors. Mercer's skill and knowledge, says Mr. Thorpe, were ungrudgingly given to his fellow-workers in the art, and his assistance and advice were constantly sought. "He had, indeed, all the essential qualities and instincts of the scientific mind, and there was a certain comprehensiveness about the man, a certain vigorous grasp of general principles, and a largeness of view which made his influence felt at once among men of science." He was the author of some useful investigation in chemistry, and an early worker in photography.

A Chase of Evil Spirits.—A very curious custom is that called the women's hunt, which prevails among some of the aboriginal tribes of Chota Nagpore, India. It is observed whenever any calamity falls upon the community—such as, perhaps, a visitation of cholera. The women put on men's clothes, take up arms, and go a-hunting—not in the jungles, but in the nearest village east of them. They chase pigs and fowls, take as their own everything they kill, and levy black-mail from the heads of the villages for the purchase of liquor, or else they allow themselves to be bought off for a small sum of money and a pig. Toward evening the hunting party retire to a stream, cook and eat their meal, drink their liquor, and then return home, having acquitted themselves during the day in a thoroughly masculine and boisterous manner. Then the village that has been visited goes on a similar excursion to the next village east of it, and so on to the eastern borders of the district. By this series of excursions it is supposed the evil spirit of the affliction is safely conducted out of the district without offending its dignity. A single village is excepted from the operation of the custom, and is called Mahadaiva, being devoted to Mahadev, and under his special protection. If cholera appears there, it is because he is offended, and he must be propitiated before it will disappear.

A Discussion about Leprosy.—A recent discussion about leprosy in the Epidemiological Society of London has made it very obvious that our knowledge on the subject is extremely indefinite. While some persons insisted that the disease was fast increasing in India and is contagious and hereditary and threatening to European countries, others brought evidence of opposite tenor. A case was cited in which a man, born of leprous parents in a leper hospital and brought up there, who married a leprous woman, had not contracted the disease at thirty years of age. Other evidence was to the effect that contagiousness is conditioned by circumstances not well understood, among which are the quantity and character of the food-supply. The influence of inheritance is as doubtful as that of contagion. On the other hand, it is certain that leprosy occurs in cases in which it has not been inherited, and no contagion can be traced.

Prunes.—Prunes are said to have been introduced into France by the Crusaders, and to have been first cultivated by the inmates of a convent near Clairac. The plum-tree is profitably cultivated in several of the departments, and grows well in any situation that is favorable to grapes. The fruit when ripe is covered with a "flower," which adds much to its value. It is usually gathered, after the night-damps have dried away, by shaking lightly from the tree, and only such as falls readily is taken. It is then put in a building, where it matures completely. Prunes are subjected to three or four cookings before they are ready for the market—two for the evaporation of the contained water, and the others for drying and giving a peculiar brilliancy to the prod-

uct. In Provence the freshly gathered fruit is plunged into pots of boiling water, where it remains till the water again comes to the boiling-point. It is then shaken in baskets till cool, and dried in the sun on trays. At Digne the fruits are peeled with the nails and strung on sticks in such a way as not to touch, and then are stuck into straw frames and exposed to the sun till the prunes easily detach themselves from the stick. The pit is then removed, and the fruit is placed upon trays exposed to the sun. In some other districts the prunes are dried in immense ovens. The first cooking of the fruit should be at a temperature not exceeding 50°, the second 70° C., while the third may be performed at 80° or 90°, or occasionally 100° C. A well-cooked prune is dark purple, has a solid and brilliant surface, is malleable and elastic to the touch, with the kernel well done and intact in the shell. When these conditions are not fulfilled, the kernel ferments, and the prune becomes moldy and worthless. Bordeaux is the principal center of the prune industry, and has a trade that is increasing.

Climate and Phthisis.—The question, Does climate cure phthisis? is answered by Dr. James A. Lindsay, of Belfast, Ireland, in the affirmative, "beyond question." It does it, not usually by a single or specific quality of the air or by any definite combination of meteorological conditions, but by removing the consumptive from the evil influences of unfavorable meteorological conditions and of an injurious soil, and transferring him to a climate where fresh air, sunshine, and outdoor life may be enjoyed and their concomitant advantages realized. The best climates to cure phthisis are found at marine resorts and mountain resorts. The best marine resort is a sea-going ship—a sailing vessel preferred—and the longer the voyage the better. Next are ocean islands, coast islands, and shore places, of which Algiers, Tangier, and Malaga are among the best. Of the dry inland resorts, the best are Nubia, the interior parts of Algeria, the Orange Free State, and the vast interior plains of Australia—of which the Orange Free State is recommended on account of its altitude. The mountain resorts have proved most efficacious in cases of delayed recovery from pneumonia, with threatening tuberculosis, chronic pleurisy with much fibroid change, incipient catarrh of the apex, and chronic tubercular phthisis, with good reaction and the retention of fair constitutional vigor. They are not good for advanced and much weakened cases; and, speaking generally, only chronic cases with fair reaction are suitable for climatic treatment.

The Crofter's Question.—The English newspapers have had much to say concerning the agitations of the "crofters" of the Highlands and islands of Scotland. The crofters are small farmers, living on rental holdings which have generally been occupied by the family through many generations, or perhaps centuries, coming down from the times when the clan system prevailed. During the present century their holdings have been abridged by the development of sheep-farming in which the landlords have become interested, and more recently by the absorption of the land in immense deer parks. The crofters naturally object to being dispossessed of estates which they have come to regard as in a measure their inheritances, and have manifested their objections in ways common to rude and ignorant men. Deprived of their accustomed homes and of the only resources which they knew how to make available, their situation became so distressing and desperate as to awaken public attention and form a leading question in Parliament. They claim a right to security of tenure, to the fixation of rent by a land court, and to opportunities for enlarging their holdings. As defined in the "Westminster Review," their troubles are not the growth of a few years, nor are they due to any faults of their own, but rest upon claims of right far older than the present civilization and *régime* of the country. The historic claim of the crofters is, that the fertile lands in the Highland glens and pastures and on the hill-sides were the common property of the clan under the chief, and that, even though the chief may have been in the eye of the law the absolute owner of the land, still in point of fact and immemorial custom the clan shared his possessions, and had an undisputed and undisturbed right to their crofts and their past-

ures or grazings, on payment of a small rent, or on condition that they served under their chief in case of war. That this was the ancient custom is not questioned. The disregard of it now shown by the landlords, with the connivance of the authorities, is excused by saying that a security of tenure, founded in the old usage of the country, can not now be seriously entertained, as the clan system no longer exists, and the property has in many cases changed hands. At the same time, the Royal Commissioners appointed to inquire into the matter admit that the present crofters are the descendants and heirs of the holders who acquired these rights, and have done nothing to forfeit them. The landlords, however, have disregarded this tenure, have evicted the tenants, and have converted their farms into sheep-walks and immense deer ranges—enforcing their pretensions with many instances of cruelty and fiendish hardship; and Parliament has done nothing effectually to remedy the evil which has been allowed to grow up.

Italian Witch-Stories.—A practice, hybrid of the legitimate healing art and of the old witchcraft, is still current in parts of Italy. Its professors are fairly trustworthy respecting what comes under their own eyes, and prescribe judiciously for the ordinary ailments of animals, but can also tell some marvelous fables about minerals, plants, and beasts; and it sometimes requires discrimination to distinguish whether they are talking from knowledge or are repeating some old fancy. According to one of their stories, if one takes the eggs from a raven's nest, boils them, and puts them back, the parent bird will bring a stone of the same shape and size which will have the power of restoring life to them. The stone, remaining in the nest after the birds have flown, becomes half transparent and like an egg in everything except weight and hardness. When placed near poisoned food, the yolk will give warning of the fact by becoming violently disturbed. If a stone the size of a pea, which the lapwing is said always to deposit in its nest, is put under the pillow of a sleeping person, the sleeper will answer truthfully any reasonable question in the language in which it is asked. A particular serpent, reputed venomous at all times, is said to be especially so in May; and the first person it bites in that month will die himself, and also cause the death of any one who may stand beside him or come to his help. The fondness of snakes for milk gives the basis for the story of a coachman into whose open mouth a snake crawled while he was sleeping by the roadside. The doctors having failed to help him, he consulted the professors of the University of Naples; they hung him up by his feet and set a bowl of milk under his head. The snake was attracted by the smell of the milk, and crept partly out to get it, when it was pulled the rest of the way out. Of course, the coachman recovered.

Outdoor Tastes of the Australians.—The climate of Australia disposes to outdoor life; hence the most is made of holidays and of excuses for appointing them, and outdoor sports flourish as in no other country. Thought is quick, and speech nimble and marked by a reckless energy of diction—as when a young woman of great skill at lawn tennis is complimented by being described as "a terror." Mr. Ernest Moon finds a more serious result of the outdoor habit in the fact that there is little time or inclination left for reading. In very few homes, indeed, are there any indications of literary tastes. "Books or periodicals are conspicuous by their absence from most drawing-room tables. The periodicals at the club may remain for days uncut. Nor are the books at the club libraries numerous or in much request. . . . There are scientific institutions, and musical and art societies, but I have been assured on very good authority that there is no literary club or society of any kind. There are, of course, other reasons for the absence of literary life besides the allurements of the harbor, the garden, or the veranda. One of them is that there is not a class of literary people."

Classes of Men.—Recognizing the inequality among men, M. de Lapouge maintains that a man is what his birth made him, and that education can do no more for him than develop the pre-existing germs derived from his progenitors in accordance with the laws of heredity. This reasoning

is extended to classes, nations, and races, who are assumed to be unequal and incapable of attaining to an equal degree of perfection. The author divides men into four classes, in the first of which he places those possessed of creative and initiative faculties above their fellows, while it is to the relative numerical preponderance of this class over the others that he refers the undoubted superiority of one race to another. He thus sees in the dolichocephalic blondes the most famed of all the races of humanity, since, from the dawn of history, all heroes and leaders among men have belonged to this type. In modern times the Anglo-Saxon race has owed its superiority to the preponderance of the dolichocephalic element. France is supposed to be suffering from the diminution of this type in its population, together with the rising preponderance of the brachycephalic type to which the lower classes of the community belong, while a great deterioration of the general personal character through the amalgamation of the two is anticipated as inevitable. Similarly the author sees in the present movement for raising the negro races a source of future danger to the Aryans, who may in time find themselves beaten down by the brute force of teeming masses of inferior brachycephalic peoples.

A Stoker's Life.—The stokers on one of the great ocean steamers work four hours at a stretch, in a temperature ranging from 120° to 160°. The quarters are close, and they must take care that while feeding one furnace their arms are not burned on the one behind them. Ventilation is furnished through a shaft reaching down to the middle of their quarters. Each stoker tends four furnaces, spending perhaps two or three minutes at each, then dashes to the air-pipe to take his turn at cooling off, and waits for another call to his furnaces. When the watch is over, the men go perspiring through long, cold passages to the forecastle, where they turn in for eight hours. One man, twenty-eight years old, who was interviewed by a reporter, had been employed at the furnaces since he was fourteen years old. He weighed a hundred and eighty pounds, and was ruddy and seemingly happy. He confessed that the work was terribly hard, but "it came hardest on those who did not follow it regularly. But if we get plenty to eat," he said, "and take care of ourselves, we are all right. Here's a mate of mine, nearly seventy years old, who has been a stoker all his life, and can do as good work as I can. Stokers never have the consumption, and rarely catch cold. Their grog had been knocked off on the English and American lines, because the men got drunk too often, and the grog did them much harm. When I used to take my grog, I'd work just like a lion while the effects lasted. I'd throw in my coal like a giant, and not mind the heat a bit; but when it worked off, as it did in a very few minutes, I was that weak that a child could upset me. Take a man dead drunk before the fires, and the heat would sober him off in half an hour, or give him a stroke of apoplexy."

Disparity in Marriage.—The "Westminster Review" shows that the widows greatly exceed the widowers in number, the proportion in England being as 1,410,684 to 589,644—a proportion which is not very greatly varied from through all the marriageable ages. The difference being hardly accounted for by the superior longevity of women, or the greater exposure to danger incurred by men, the "Review" finds a more efficient cause in marital disparity. Women prefer husbands who have made their fortunes and can give them ease and display, to young men who have their fortunes to make, with privations that must be shared. Thus taking companions considerably older than themselves, they naturally outlive them. It might be a more philosophical proceeding for the woman to marry a man younger than herself, that she may have his society through life, and a support when she will most need him. The results of this course to the cause of purity and to the health of the human race are to be deplored. Disparate unions have been shown to be fertile sources of the failure of marriage. A young woman marrying a man of like age is the right person in the right place. On the contrary, in marrying a man at the end of his manhood, she often drags him down. "Gross disparity was forbidden by Jewish lawgivers, and also by the most

enlightened of pagan legislators. Is it wise or prudent to permit the vigor of manhood to be dissipated or wasted, and to allow posterity to owe its origin to the waning strength of old men? It is certainly contrary to the warning voice of the most intelligent and disinterested of the medical profession. . . . This widow-making vice of marital disparity is but one feature in that hymeneal profanation which is the curse and disgrace of our age, as it was of the decline of Rome."

Climates of British Health Resorts.—The isothermal lines in the British Islands run north and south rather than east and west. Hence latitude is there a less sure guide to temperature than longitude. All the health resorts on the east coast have a very similar character, although they differ so much in latitude; and the like rule holds good on the west coast. The resorts on the south coast differ materially, according as they lie toward the east or toward the west. As a general rule, the east coast resorts are dry, somewhat cold and bracing, while the west coast resorts are relatively humid, mild, and relaxing. All the coasts are more or less windy; but there is a great difference between the dry, somewhat parching, and decidedly bracing wind that comes to the eastern coasts across the German Ocean, and the soft, rain-laden breezes of the Atlantic. Some places, however, have a climate of their own, depending upon peculiar conditions. The line between the bracing and relaxing of the south coast resorts lies near the Isle of Wight. The most bracing resorts in England are those of Durham and Yorkshire; the most relaxing those of Devonshire and Cornwall. The resorts from the mouth of the Thames to Brighton form an intermediate class.

Distinctive Characteristics of Horse-flesh.—The inspector of slaughter-houses in Paris distinguishes between horse-flesh and beef by the following marks: Horse-flesh is reddish brown, becoming darker on exposure to the air; it has an odor peculiar to itself; it is soft and slightly tenacious, allowing the finger easily to sink into it, and the fibers, when worked, break up and become pulpy; the muscular fibers are long and fine, and united by very compact cellular tissue; in cooking, it hardens and becomes more dense and compact than beef; and under the microscope the fibers and striations of the muscular tissue are finer than in the flesh of the ox. These differences not always appearing sharply defined enough to make the distinction infallible, James Bell has sought other tests, and found them in the character of the fats. It was observed that the adipose tissue of the horse was of a softer and more oily nature than that of beef. On melting, horse fat, at 70° Fahr., formed a clear oil; the melting-point of beef fat, which is solid at ordinary temperatures, varied from 110° to 116° Fahr. At 100° Fahr. the specific gravity of horse fat ranged from 908·4 to 908·8; the specific gravity of beef fat, at 120° Fahr., was from 903·6 to 904. These important characteristics of difference, particularly the fluidity of horse fat at 70° Fahr., make the distinction between the two fats very plain.

Mental Powers of Spiders.—"Some Observations about the Mental Powers of Spiders" are recorded by G. W. and E. G. Peckham in the "Journal of Morphology." The authors experimented on hundreds of spiders of most of the common genera and species, with relation to such faculties as they may be supposed to possess, but found the way to knowledge on the subject "long and beset with difficulties." The faculty of smell seemed to be fairly developed in all but three out of twenty-six species. It was exhibited in different ways—by various movements of the legs, palpi, and abdomen, by shaking their webs, by running away, by seizing the rod conveying the perfume and binding it up as they would an insect, and by approaching the rod with the first legs and palpi held erect. The position of the organ of smell is unknown, and was not found. In hearing, spiders made no response to any loud or sensational sounds, but all the Epeirids were sensitive to the sound of the tuning-fork, while the spiders that do not make webs gave no heed to it. In love of offspring, all the spiders eagerly received back the cocoons when they had been deprived of them for various periods inside of twenty-four hours; some failed at twenty-four hours, while only a few recognized them after a longer period. They did not, however, seem able to

distinguish their own cocoons from another spider's, or from a pith ball of the same size; and one of them even accepted a lead shot over which the covering of a cocoon had been stretched. In the sense of sight, they had great difficulty in finding their cocoons, even when removed from them only three quarters of an inch, and performed long and tortuous routes before they reached them; but in other matters they showed that they could see well enough. The trouble about the cocoons arose from the fact that the spiders never see them when carrying them, and therefore did not know them by sight, but depended on touch to identify them. The color sense appeared to be fairly well developed, with a very decided preference for red. The authors do not believe that spiders feign death. Epeirids drop and lie still for a time, but that is because, if they run about, they have difficulty in finding the thread that leads back to their web. Other spiders keep still, if at all, only for a few moments, but not long enough to give an appearance of death. Darwin's explanation is, therefore, correct, that the habit of lying motionless is the result of natural selection, and has been acquired by different species in different degrees, according to its usefulness in their various modes of life.

A Patriarchal Estate.—A patriarchal system of management is on trial on the estate of five thousand acres of Baron Raimondo Franchetti at Canedole, Mantua, Italy. Machinery and manures are liberally employed. Nobody pays any rent. The parish priest, schoolmaster, and doctor are employed and maintained by the proprietor. Sixty children are fed and looked after during the day in the Kindergarten, to and from which they are conveyed in an omnibus. The buildings are grouped, at the Corte de Canedole, around a square of fifteen thousand square yards area, with the master's house facing the entrance, and the steward's and other farm officers' dwellings, and the workshops, stables, barns, etc., near at hand. The whole is surrounded by deep canals flushed with running water, and flanked by avenues of plane-trees. Watchmen go their rounds at night. Work-hours are regulated by the sound of the bell; strict discipline is enforced; the upper hands set the example of steady and serious work, and grand balls are occasionally given by the baroness in the court-yard to all the peasants. It is not known how profitable the experiment has been, but it has not been a failure.

The Human Factor in Slums.—Mr. Frederick Greenwood, in a discussion in the "Nineteenth Century" of the problem of "Misery in Great Cities," maintains that the slums and squalid dens that abound in parts of London—and other enormous cities—"correspond far more than most kind souls are willing to perceive to the measure of depravity and weakness of the human mind; and at the same time to the proportion of incapables in a state of society which does not allow its incapables to perish." Every village and town has its bad spots and its centers of degraded population, corresponding in extent with its size; and it is only the vast extent of the mischief in London, commensurate with the dimensions of the city, and the appalling magnitude of the problems which it suggests, that excite so much commiseration and alarm. Hence it may be concluded that any local and spasmodic efforts to ameliorate the evils that exist are destined to only a very limited success, and that permanent advantage is likely to accrue only from measures that tend to raise the general social condition.

Inheritance of Acquired Habit.—In illustration of the hereditary transmission of characteristics acquired by habit, Prof. M. M. Hartog relates in "Nature" the case of a person who is unequally myopic in his eyes, and very astigmatic in the left one. On account of the bad images given by this eye for near objects, he was compelled in childhood to mask it, and acquired the habit when writing of leaning his head on the left arm, so as to blind it, or of resting the left temple and eye on the hand, with the elbow on the table. After putting on spectacles, when fifteen years old, he lost the habit of leaning. His two children, while they have not inherited the congenital defect, being emmetropic in both eyes, have received his acquired habit, and have to be watched to keep them from hiding the left eye when writing. A somewhat similar case of inheritance of acquired habit is related by J.

Jenner Weir of a goat and its kids in the Zoölogical Gardens. A chain was attached to the animal's neck to keep him from jumping over the fence. He became accustomed to take the chain up by his horns and move it from one side to another over his back; in doing this he threw his head very much back, so as to place his horns in a line with his back. His offspring have inherited this habit, though it has not been necessary to put chains upon them.

NOTES.

According to Mr. F. F. Payne's paper in the Canadian Institute, the Eskimos of Hudson Strait have a right to be called keen observers of nature. The author found them of great assistance while he was making his collections of birds, insects, and plants. "If an insect was shown them," he says, "they could usually take me where more of the same species might be found. On the approach of summer, they watched with more interest its signs, and often would bring to me insects which they believed were the first of the season."

The use of borax for the preservation of milk, which has become quite common when the milk has to be carried for a considerable distance, has suggested the question whether we may not have in this a means of promoting immunity against scarlet fever. Recent investigations have shown that this disease is often carried by milk, and in all probability frequently starts from cows. It has been remarked by Prof. W. Mattieu Williams that in all the cases where an outbreak of scarlet fever has been traced to milk, the dairy has been a local one—that is, a dairy that has supplied milk to families in its own immediate neighborhood, or so near as to render the use of borax unnecessary.

Fish-meat according to Prof. Atwater's researches, does not contain more phosphorus than ordinary butcher's meat. The benefit which brain-workers are said to derive from a diet of fish should therefore be ascribed, not to the phosphorus, but to the greater digestibility of the fish. The excess of phosphorus in the urine of such persons need not be regarded as a resultant of brain-work, but as an indication of the disordered digestion to which sedentary persons are liable. The recent researches of Zuelzer and others seem to indicate that excessive elimination of phosphorus by the urine is associated with nervous depression rather than with nerve activity.

Several instances of apparent counting are mentioned by Sir John Lubbock, in his "Senses of Animals," as exhibited by insects. The several species of *Eumenes*, for instance, supply their young with definite numbers of victims; and, while the males are smaller than the females, and require less food, the insect seems to know whether the egg will produce a male or a female grub, and apportions the quantity of food accordingly, giving five victims to the male and ten to the female. It is suggested by Mr. G. A. Freeman that the matter is one of physiological interval. The male eggs follow one another in less time than the female, giving time to store a smaller number of caterpillars before the next egg has to be provided for.

Powdered milk is prepared by reducing fresh milk, after having removed a portion of the cream, in a vacuum-pan, to the consistency of ordinary condensed milk. Granulated white sugar is next added, to render the mass sufficiently friable, and the temperature is lowered some twenty or thirty degrees. The contents are then removed from the vacuum-pan, and distributed in lumps, or reduced to a powder. It is claimed that powdered milk possesses excellent keeping qualities, even in moist air at high temperatures.

Dr. B. W. Richardson sounds the praises of a vegetarian diet when he assumes, in his lecture on "Ideal Foods," that what is commonly called happiness—lightness of heart, rapidity of thought, and all else that springs from a happy life—is connected with what we take as food. That happiness is best sustained by those foods which minister quickest and with least trouble to the digestion, and therefore to the wants of the body. Sir James Hannen had been struck, when he changed from animal food to a nearly vegetarian system, by the state of happiness that he experienced, compared with what he had felt before. The speaker had also felt this in his own life, and most when he was most nearly a vegetarian.

Although it was written in French and translated from that language into English, Prof. Guyot's "Earth and Man" has only recently been published in French for the first time.

The security of the Davy safety lamp has been partly improved, while a remedy has been found for the obscurity produced by the use of Marsant's safety bonnet, by the application of Mr. Andrew Howat's "deflector." The leading feature of this device lies in a flanged ring which is to be fitted tightly between the outer metal shield or bonnet and the gauze cylinder, by means of which all the air admitted for combustion is carried under or near the bottom of the bonnet and passed through the gauze into the burner part of the lamp. A brilliant light is thus obtained. This lamp has been passed through some severe trials, and has always been extinguished at once when exposed in a current of explosive mixture.

MR. THOMAS WARD assigns the causes of subsidences which have taken place at Northwich and its neighborhood, Cheshire, England, to the pumping of brine for the manufacture of salt. The first subsidence was noticed about 1770. The sinking has since gone on very rapidly, and much destruction of property has resulted. Large lakes or "flashes," one of more than one hundred acres in area, and of all depths down to forty-five feet, have been and are being formed.

IN Central Africa, according to Dr. Junker, an almost perpetual state of warfare prevails. The abduction of a woman is often sufficient to engender strife; and, consequently, the abodes of the Central African tribes and their political conditions are subject to continual and incessant changes. If a conquered tribe will not surrender its territory, it falls into a condition of bondage to the victorious race. It can not be said that one district is wholly occupied by one race, but the population is in every case very mixed and composed of the most diverse elements.

THE Akkas are described by Dr. Junker as the only voluntary nomads of the Central African regions. They construct their little cone-shaped grass huts in the shelter of the trees of the woods, and live in a district as long as the chase lasts. They prefer to abide among some tribes and avoid others. The rulers welcome them, and they, being practiced archers and cunning warriors, are employed in the invasions of the territories of neighboring tribes. They possess no industry, and buy even their arrow-heads in exchange for meat, the produce of the chase. They are timid and suspicious, and Dr. Junker only once saw about one hundred and fifty of them together. They can not properly be described as dwarfs, but only as relatively very small men.

M. JEAN LUVINI supposes that the electrical manifestations of the atmosphere are produced by the friction of particles of water and ice, and such other substances as may be lifted to the upper regions and dispersed through several miles of thickness. The differences in the character of the manifestations are dependent upon differences in intensity. Auroral lights are due to discharges in rarefied air.

A SAILING vessel of new construction has undergone a successful trial at Southampton, England. Its peculiar feature is the shape of the submerged part, which is that of a W, with the angles well rounded off. The two keels are of brass, and hollow, so that the water flows through them from end to end. The vessel possesses remarkable buoyancy.

THE Medico-Chirurgical Society of Edinburgh, discussing recently the subject of further legislation for habitual drunkards, were agreed that past legislation in the matter had been a complete failure. The present law presupposes the consent of the patient to measures for putting alcohol out of his reach for a year; the proposed new law, which the society approved, will do away with this condition. Sir D. Maclagan regarded the so-called "liberty of the subject" in such a matter as this as "an intense humbug." Dr. Batty Tuke insisted on a distinction between those whose drunkenness was a pure vice and those with whom it was an insanity; to which Dr. Yellowlees objected that it was hard to "house respectable lunatics with the class of habitual drunkards."

IN a paper on "Clothing," Mr. Francis Vacher insists, as a primary consideration, on the importance of wearing clean, porous, and warm woolen clothing; condemns aniline and other injurious dyes; exposes the evils of scanty clothing, unequal pressure, heavy superfluous ornaments, ill-adjusted corsets, and high-heeled boots; discriminates between different styles of children's clothing; and pronounces the morning suit and under-wear of men nearly perfect.

As the conditions are set forth in Mr. J. B. Bailey's work on "Modern Methuselahs," moderation in eating, drinking, and living are conducive to long life. Persons in a comfortable position and of average intelligence enjoy better prospects for a long future than those at either extreme. "Earnest and ungrudging exercise of the mental powers appears to be no bar to old age, and at times to favor it; but, as a rule, while a moderate use of the faculties tends to health and endurance, excessive use of them has often, directly or indirectly, had a reverse effect."

FOR the removal of tattoo-marks from the skin, M. Variot recommends, in the "Revue Scientifique," covering with concentrated solution of tannin and retattooing in the part to be cleared; then rub with a nitrate-of-silver crayon, when the parts will turn black; sprinkle tannin-powder on the surface several times a day. A dark crust will form, which loses color in three or four days, and in a fortnight or so comes away, leaving a reddish scar free of tattoo-marks, which in a few months becomes little noticeable.

THE question whether the cuckoo ever hatches its own eggs is still a subject of active discussion. Herr Adolf Müller has lately described a case which he himself claims to have observed. Herr Adolf Walter, who has not observed a case, thinks Dr. Müller is mistaken. An incident related by Dr. Erasmus Darwin is cited in evidence for the affirmative; but, as Dr. Darwin and his authority are beyond the reach of cross-examination, the adherents of the negative refuse to receive it.

ROBERT KOCH.